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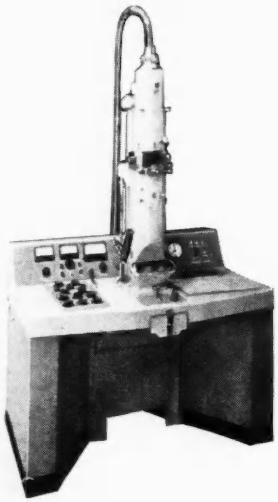

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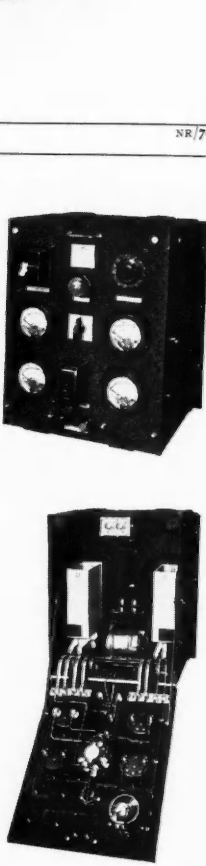

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COVER PICTURE: An artist's impression of dew collecting on a desert plant. A full article on dew and its usefulness for arid agriculture appears on page 330.

"Many difficulties occur in the pursuits of the dairy farmer which render his occupation precarious. Such difficulties arise entirely from an ignorance of the scientific relations of the practice in which he is engaged."

Such difficulties arise

Evidently the scientific approach to dairy farming was already an active force 112 years ago, for the sentences quoted come from a paper 'On the Changes in Composition of the Milk of a Cow according to its Exercise and Food' delivered by Dr. Lyon Playfair in January 1843 and recorded in the first issue of the Journal of the Chemical Society. Modern dairy physiologists prefer to use a herd, or identical twin cattle, in their feeding tests, rather than the one cow of Dr. Playfair. Dairy analysts also seek greater accuracy in their control methods and find it by using B.D.H. reagents specifically prepared for milk testing purposes:—

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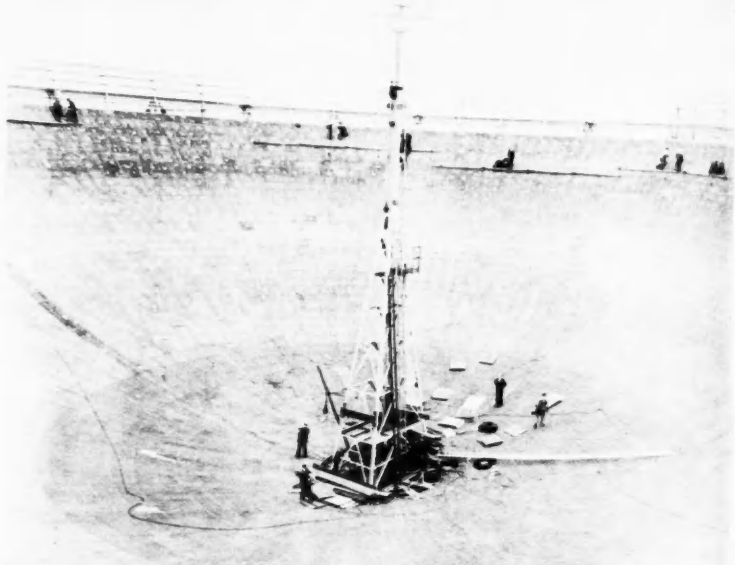
THE PROGRESS OF SCIENCE

BRITAIN'S 3000-INCH TELESCOPE

Each piece of research is unique: its function is to do something which has never been done before. In this continuous search for new knowledge, a tendency has become apparent in the last ten years which is in itself significant. Great engineering constructions are needed if this search is to be continued into some of the new and unexplored problems. An outstanding example of this tendency is the proton synchrotron described by its engineer, J. B. Adams, in DISCOVERY last month. Although not engineering feats comparable to the Comet aircraft or the Calder Hall atomic power station, the proton synchrotron, and now the giant radio-telescope at Jodrell Bank, are pure research instruments without any utilitarian applications. Jodrell Bank must be the largest research instrument in this country and possibly in the world.

Its existence is entirely due to two men: Dr A. C. B. Lovell, F.R.S., Professor of Radio-astronomy in the University of Manchester, and Mr H. C. Husband, the well-known engineer. As long ago as 1948 Prof. Lovell conceived the idea of a radio-telescope with a 250-foot-diameter reflector; and in 1952 the first foundation point was laid. By the time this issue is published the last rivet will be in place and the last reflector plate will have been welded to the structural rim of the reflector. Another month or two must then elapse for the calibration of the telescope, and it is expected that towards the autumn the first scientific measurements will be made.

The engineering difficulties in the construction of this telescope were very great indeed. The dead weight of it is 2000 tons, and the bowl alone weighs 750 tons. Yet the whole structure must move exceedingly smoothly and slowly in order to compensate for the diurnal movement of the Earth. This is achieved by the use of powerful electric motors and a gear reduction of more than one to two thousand. The height of the telescope is staggering when one stands below it, and at 300 feet it greatly exceeds Nelson's Column in Trafalgar Square. Experiments were carried out in the wind tunnels of the National Physical Laboratory to achieve a design able to withstand the maximum wind pressures likely to arise on the site. A real impression of the magnitude of the instrument can only be gained by climbing to the very rim of the reflector and looking from there across the countryside of Cheshire. The constructional work was entirely carried out by the United Steel Structural Company, and one might have thought that aluminium would have been a better material. However, the high modules of elasticity of steel made it a preferable



A photograph taken inside the giant reflector bowl at Jodrell Bank, showing the laying and welding of the last plates of the outer rim. The bowl is 250 feet in diameter, and in the centre is the structural mast carrying the receiver aerial.

A view of the reflector bowl taken from underneath, showing in the centre the "hanging laboratory". This is suspended in such a way that even if the reflector bowl turns through an angle of 180°, the floor of the laboratory remains horizontal and stationary. Careful inspection of the photograph will show that a second upside-down catwalk will allow scientists to reach the laboratory when the bowl is turned through 180°. (*This photograph, and that reproduced on p. 319 showing the desk at which the controller will sit, are Crown copyright and are published by kind permission of the Central Office of Information.*)

material; aluminium has also a high coefficient of expansion. It would stretch too easily and would therefore introduce inaccuracy, which had to be strictly avoided.

Precision was also required for the rails on which the telescope turns. These had to be laid to an accuracy of 1/16 inch, and the wheels riding on them had to be conical with the central trunnion of the telescope. The driving speed of the telescope bogies is half a mile per hour under normal conditions, but a large power reserve is available in order to turn the telescope against high winds in adverse conditions.

Radio waves reach us mainly from three sources in the Universe: from the concentration of hydrogen gas in the plane of our own galaxy; from the so-called radio stars, and from our own Sun; and perhaps most extensively from the collision of two galaxies in the depths of space. It is this last source of radiation which might well hold the clue to the origin of the Universe, and if Prof. Lovell's hopes are fulfilled this single instrument may greatly contribute to our fundamental knowledge. So far, three instances of this extraordinary cosmic phenomenon have been recorded, both optically at Mt Palomar, and by radio-telescopes in other countries. These collisions, although giving only the faintest of optical images, are exceedingly strong sources of radiation and can be located with even small radio-telescopes. It is therefore to be expected that, with the immense reflector of the Jodrell Bank telescope, similar collisions may be detected. The mere fact that they are at the outer limits of our optical penetration of space, and yet are strongly received by small radio-telescopes, gives hope that this more powerful radio-telescope will penetrate far beyond our present knowledge to the very edge of the Universe. Prof. Lovell hopes to reach the sources of radiation a thousand to two thousand million light years away. Should it be found during this work that the density of these radio sources increases with the distance, this would support the theory of an expanding Universe. If, on the other hand, the density should remain constant, it would give support to the theory of continuous creation of matter. Experimental verification of these theories would indeed be most welcome, and would fully justify the single-minded determination of the creators of the telescope, who had to overcome many difficulties in order that their dream might come true.

THE OPENING OF THE IGY

Two outstanding events took place at the end of June to open the International Geophysical Year. The first was the Royal Society Conversazione; the second, Prince Philip's television broadcast.

Setting a new precedent in grace and uniformity of display, the Royal Society showed in an interesting and stimulating manner the activities of the IGY. Most sections of the programme were represented, and elaborate maps and diagrams left no doubt of the IGY's international character. Among the outstanding exhibits was a beautiful model showing how solar activity can produce magnetic storms and auroral displays. Dr W. G. Beynon and Mr G. M. Brown of the University College of Swansea were responsible for this display. The model, not larger than a small table, consisted of a series of white flashlight bulbs encased in vertical spirals of wire representing incoming solar radiations—which produced in a case of Perspex—the ionosphere—blue lights simulating the phenomenon of aurora. Below the Perspex was a map of the Antarctic in which a number of compasses were inlaid.

A whole room was devoted to the "Skylark" rocket, and the research which will be carried out with its aid. Prof. H. S. W. Massey, F.R.S., showed how the temperature of the upper atmosphere will be measured by the explosion of grenades ejected from the rocket, how chemical experiments can give us a clue to the composition of the upper atmosphere, and how the resulting data on these and other researches will be transmitted back to Earth by telemetry. In the courtyard of Burlington House was one of the actual "Skylark" rockets which will later be fired in Australia.

The National Institute of Oceanography showed its famous "pingers" and some of the excellent photographs obtained of the ocean bed. The Meteorological Office displayed its radio-sondes. Dr Ellison had interesting photographs of equipment bringing together the various activities of the IGY as influenced by the Sun.

The organisers of this Conversazione are to be congratulated on this outstanding presentation of the many complex aspects of the International Geophysical Year. However, it is most unfortunate that such an informative display should come into being only for the few hours of the Conversazione, and should not reach a very much wider number of scientists and also the general public.

The Royal Society is also to be congratulated on its excellent publication, "The United Kingdom Contribution to the International Geophysical Year, 1957–8" (10*s*.), with a foreword by the President of the Royal Society. The distribution of the 153 U.K. and joint stations is given, and there is a chapter on the establishment of the Royal Society Base at Halley Bay. The book deals with each of the fifteen disciplines, and describes in what aspects the United Kingdom is particularly active. Behind the accounts written by the participating scientists lies the careful editorial work of Dr D. C. Martin.

Equally important is the appearance of the first four parts of the *Annals of the International Geophysical Year*,* edited by W. G. Beynon and G. M. Brown of the University College of Swansea. A section on Ionospheric Vertical Soundings is followed by Measurement of Ionospheric Absorptions, Ionospheric Drifts, and Miscellaneous Radio Measurements. These, with their many diagrams and photographs, will prove of great permanent value.

The appearance of a great solar flare a few days after the beginning of the IGY made headline news. The IGY has certainly stimulated popular imagination, a fact which is due, to a great extent, to Prince Philip's appearance on television.

* Pergamon Press, London, New York, and Paris.

The opening of the IGY was celebrated in many ways. Our photograph shows the bar in the living room of the base hut of the Royal Society's station at Halley Bay. On mid-winter's day, June 21, this room must have seen a gay party.

"TO HAVE ASPIRING MINDS"

But if the Soirée at the Royal Society brought the IGY to life for a few distinguished scientists, then the BBC's television programme on the evening of June 30 did the same for millions of ordinary people who, in spite of the hottest day of the year, looked at their television sets. The programme had been planned for almost a year, and when, in February 1957, Prince Philip agreed to act as narrator, the BBC decided to make the opening of the IGY the occasion of its "most complicated and massive programme ever attempted". It has been stated that the cost exceeded £20,000, and it is a sobering thought that what was spent on television in 75 minutes is probably as much as has been spent since 1945 on the "Science Survey" sound broadcasts on the Home Service. Assuming a television audience of ten million for the IGY programme, this would bring the cost down to a ha'penny a viewer.

The high cost of the programme must, to a large extent, have been due to the live outside broadcasts which took in such scenes as the activities of Vesuvius in Italy and the research activities at the Jungfraujoch in Switzerland. It might well be questioned whether live outside broadcasts are really worth it to portray scientific research, and whether films of precisely the same events would not have given as good if not a more perfect impression. In fact, as Vesuvius proved extremely quiet during the hour of the broadcast, a film taken a few days earlier was shown instead, when Vesuvius was more obliging. If the costs of this or similar programmes could be reduced, then the BBC might well repeat a world-wide coverage of Science in other fields than the IGY.

On the whole it was a most inspiring performance, and one that must certainly have given the scientists and those interested in the activities of the IGY a more complete picture of the international working of science than any other medium could have done. It was aimed at a Third-Programme audience, and one can well imagine that the man in the street might have come away with the impression that scientists were an esoteric international brotherhood whose diverse and complex instruments are invented for their own private purposes. Incidentally, no single woman scientist appeared on the screen with the exception of a number of technicians at the Woomera rocket range in Australia. It is difficult to see how the complexities of geophysics could be explained to the ordinary television viewer. If he received from the programme the impression that peaceful scientific co-operation is not a bore—Prince Philip's opening phrase—then every ha'penny of the £20,000 was well spent.

Prince Philip acted as a non-scientific narrator, and to have sustained with his personality 75 minutes of television is an excellent achievement for any commentator, whether amateur or professional.

An excellent point that came out from the programme was that rockets can and will be used for peaceful purposes, and although the amount of time devoted to them was out of proportion to their total contribution, such dramatic licence in a programme of this kind is allowable.

Many of the scientific scenes shown on television made history. The whole sequence on rocket research at Woomera was the first that scientists and public had ever seen of this research station. It was interesting to note that Swiss cine-theodolites were used, and that the firing of the rocket was visually observed through a periscope. Also seen for the first time were time-lapse

films of the development of the *Aurora australis* as recorded in the all-sky camera in the Antarctic. The producer's imagination in coupling a television camera to the all-sky camera and presenting to the audience a 180°-view of the studio must be highly praised. The time-lapse sequence of the ionospheric records and the sunrise shown on these charts deserve equal praise.

The studio set was excellent, and a continuously revolving globe—"the restless sphere" which gave its name to the programme—was a delightful touch. However, it is unfortunate that probably the most expensive model in the studio, the three concentric transparent Perspex globes, was a failure. It was meant to portray the Earth's surface, the weather, and the ionosphere. But owing to lighting difficulties it became a complex of reflections which could not be analysed by the viewer. It would have been easy to remove a conical section from it, as was done in the model of the Earth itself, and thus show the viewer the various heights of the three layers.

It can only be hoped that the BBC has learned from this programme that science can make excellent television material and that a large expenditure on planning and world-wide coverage of a particular subject is well worth while. The programme received an excellent press the next morning. *The Times* called it "the old-fashioned kind of lantern lecture brought up to date". The *Daily Express* referred to it as "the middle-brow's finest hour". The *Manchester Guardian* referred to the Annigoni look; and the *Daily Telegraph* science correspondent's nine-year-old son decided to become a scientist, after seeing the programme, instead of a doctor.

It is fortunate that the whole of the programme has been recorded on film, and that it will be widely shown in other countries. It can only be hoped that the BBC, in collaboration with the Royal Society, will present further similar programmes about science. Instead of retreating from its unique position, the BBC should go forward and show in an appropriate manner that science is the greatest adventure of the 20th century.

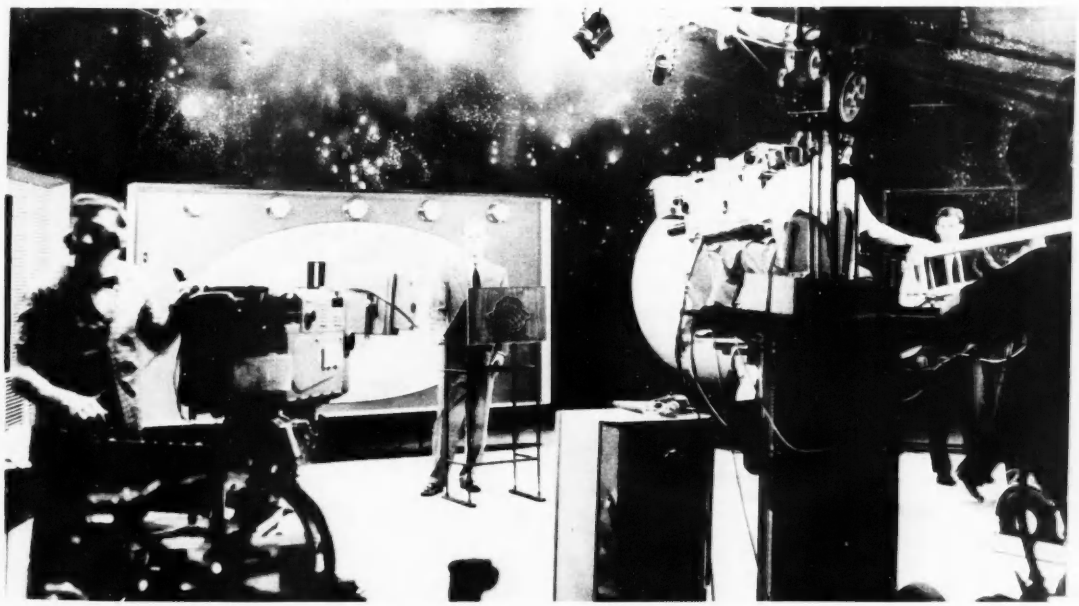
THE ACCADEMIA DEL CIMENTO (1657–67)

The Accademia del Cimento—the Academy of Experiment—which first met three hundred years ago, was one of a number of scientific societies which grew up in the 17th century:

Rome	Accademia dei Lincei	1600–30
Rostock	Societas Ereunetica	1622–24
Schweinfurt	Collegium Naturae Curiosorum	1652–
Florence	Accademia del Cimento	1657–67
London	Royal Society	1660–
Paris	Académie des Sciences	1666–
Altdorf	Collegium Curiosum sive Experimentale	1672–
Berlin	Berlin Academy	1700–

Like many of the above, the Accademia del Cimento grew out of informal gatherings of men interested in the new experimental philosophy. Meetings were held from about 1651 and centred around Leopold Medici, who with his brother the Grand Duke Ferdinand II brought the Academy into being. They had both been pupils of Galileo and of Torricelli and Viviani, and had built up a laboratory in Florence with a fine collection of instruments, animals, and rare plants, all of which were made available to the Academy.

A characteristic of the Academy was its exclusive concentration on experiment; it showed no sign of the



H.R.H. Prince Philip in the Lime Grove Studios of the BBC, during his television broadcast on the IGY on June 30. Note the teleprompters in front of the television cameras.

Baconian influences which led, for example, the Royal Society to set up a Committee for Histories of Trades. Equally it showed no interest in theoretical problems. The meetings, held in private, were quite informal, the only official being the secretary, who prepared the instruments. Although particular problems were allotted to individuals, the work of the Academy appeared in the name of all the members.

The most famous of these is G. A. Borelli (1608–79), a pupil of Galileo, who was connected with the Academy throughout its existence. An excellent mathematician, he also made contributions to astronomy and physics, but is best known for his work in physiology. The mechanics of muscular action were placed on a scientific basis in his *De motu animalium* (1680), in which all bodily movement was discussed in purely mechanical terms. His work at Florence was chiefly on air pressure in relation to breathing and on capillarity, and he also carried out experiments on the pendulum. With Viviani (1622–1713), also a pupil of Galileo, Borelli had the task of demonstrating the experiments, and together they made measurements on the velocity of sound. Viviani constructed the first barometer for Torricelli and was an eminent mathematician.

In 1666 the Dane Niels Stensen, or Nicolaus Steno (1638–86), became physician to Ferdinand Medici and was associated with the Academy during its last years. His work on geology, mineralogy, and crystallography culminated in his *De solida intra solidum* (Florence, 1669) which contained important observations on crystals and the first formulation of principles involved in the formation of strata. He described the earth's crust as "parallel layers, containing remnants of organic matter"—for he also maintained the organic origin of fossils. Another famous member was Francesco Redi (1621–97), "at once poet, antiquary, physician and naturalist" (Singer) who is best known for his experiments on spontaneous generation.

The work of the Academy was published in 1666 as *Saggi di naturali esperienze fatte nell' Accademia del Cimento* (English translation by Waller, *Essayes of Natural Experiments made in the Academie del Cimento*, 1684). This first dealt with the construction and use of thermometers and other instruments. Most detailed attention was then given to the study of atmospheric pressure. Torricelli's barometric studies were repeated; it was shown that atmospheric pressure decreased with increasing altitude, and the effects of the vacuum on many phenomena and properties were investigated. Later, with a vacuum pump, some of Boyle's experiments were repeated and Borelli first showed experimentally that air was necessary for the maintenance of life.

Much attention was also given to the study of phenomena of heat and cold, including the expansion of water on freezing, and the force of this expansion. Bacon's experiments on the compressibility of water were repeated, with the conclusion that water was certainly highly incompressible, though they would not conclude that it was absolutely so. Other matters investigated included magnetism, colour changes of liquids, and the process of digestion. The influence of Galileo can be seen in attempts to repeat his measurements of the velocity of light, and in the carrying out of experiments which he had suggested on projectiles.

The Academy had a number of corresponding members; it was in correspondence with Boyle and Huygens, amongst others, and distinguished visitors attended its meetings. Its influence and example led to the formation at Altdorf in 1672 of the *Collegium Curiosum sive Experimentale*. It is noteworthy that in its work on the vacuum, the Academy was one of many groups, including the Royal Society and the Académie des Sciences, whose work ultimately led to the steam engine and the "pneumatic revolution" in chemistry.

When Leopold Medici became a Cardinal in 1667 the Academy came to an end, for it had depended entirely on his patronage and, for example, when he moved, the meetings had either ceased or moved with him. Tradition has it that the closing of the Academy was a condition required by the Pope, though the Cardinal's interest in science apparently continued and the dissolution has been attributed to quarrels between Borelli and Viviani. Whatever the cause, the closing of the Academy saw the virtual end of experimental physics in Italy and the leadership passed to France and England. The Italian tradition was to be revived by Galvani and Volta over a century later.

The achievement and fame of the Academy rests on the quality of its experimental work; as Poggendorff wrote: "Few bodies have so well fulfilled their aims; the academicians solved the problems they proposed to themselves; we stand today on their shoulders."

SURFACE MICRO-STRUCTURE OF DIAMONDS

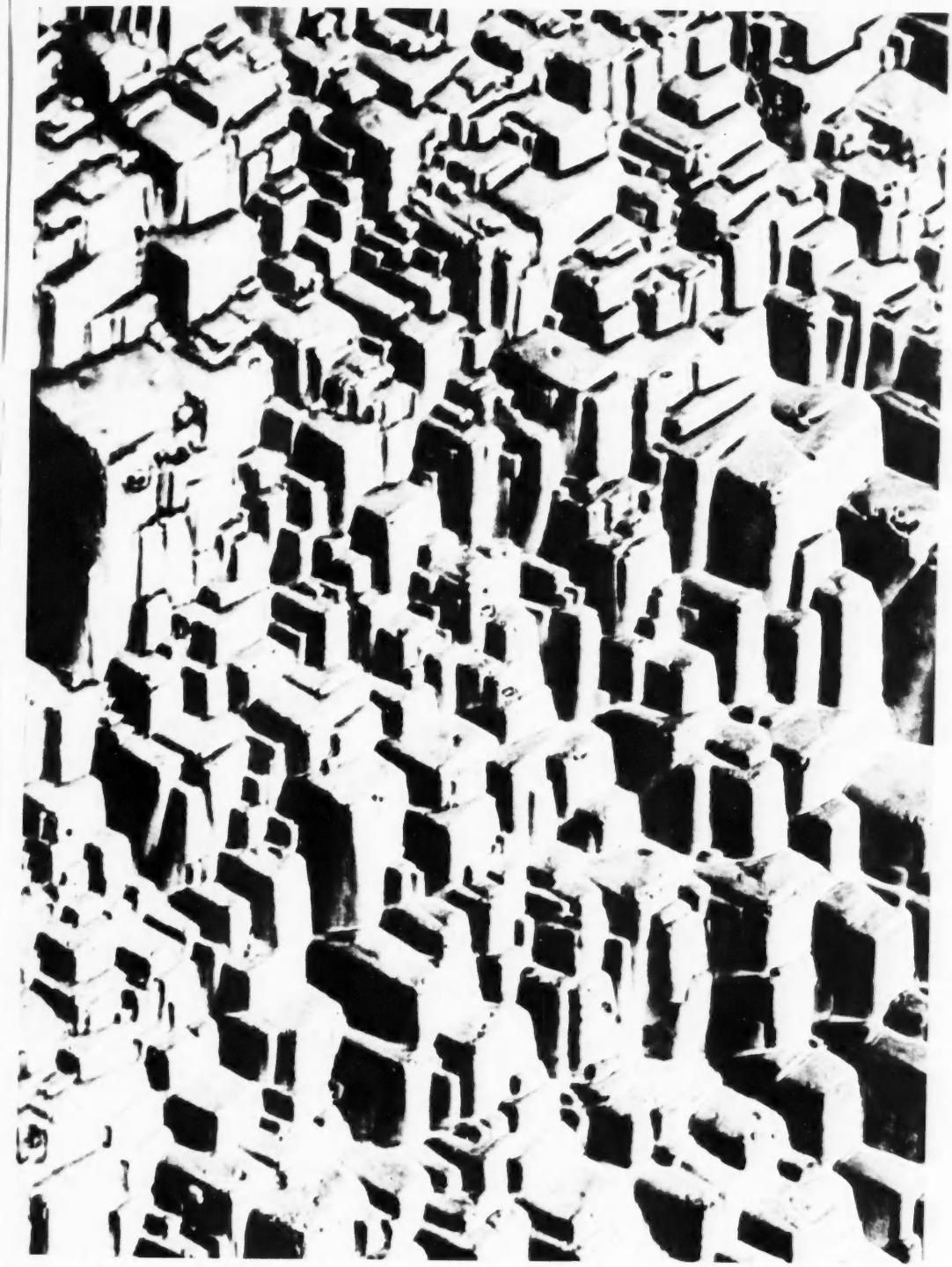
Traditionally it has been known that diamonds etch when heated in oxidising atmospheres, and oxidation temperatures exceeding 900°C have generally been quoted. Within recent years Prof. S. Tolansky, F.R.S., has shown that much structural information is revealed on diamond surfaces by employing a particularly mild rate of etch. This is done by immersing the diamond in a flux of potassium nitrate at temperatures between 500° and 650°C, but no higher.

On natural octahedron faces of diamond, the slow etch takes place in three successive stages. First, surface imperfections, dislocations, and cracks receive preferential etch. This is followed by widespread development of triangular (60°) shaped etch pits. Third, when the triangular pits encroach on each other, a beautiful block-structure is revealed, enhanced in appearance by using oblique illumination on the microscope. The block edges are rounded, and in places secondary micro-pits appear on the blocks. The depth of the etch is of the order of 1/1000 cm.

Prof. Tolansky has nicknamed this picture (on p. 325) the *Diamond Manhattan Skyline*.

STRATA BOLTING IN MINES

During the last decade there has been a revolution in the systems and types of roof support applied in the coal mines of Great Britain. The traditional wood and rigid steel props used on the coal face are being replaced by



Surface micro-structure of diamond etched at 650° C, magnified × 1500. (*By courtesy of Professor S. Tolansky, F.R.S.*)

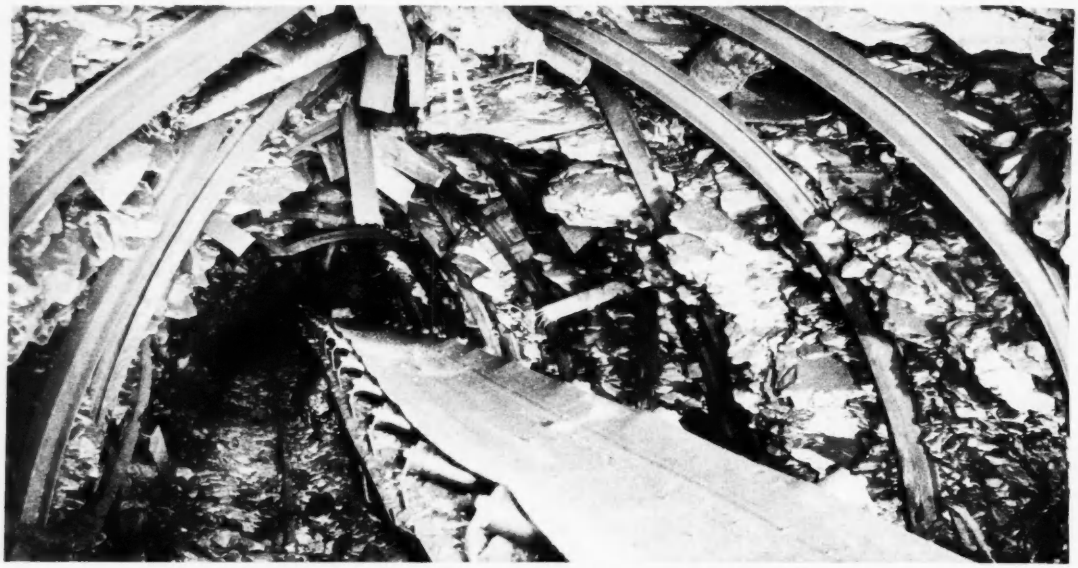
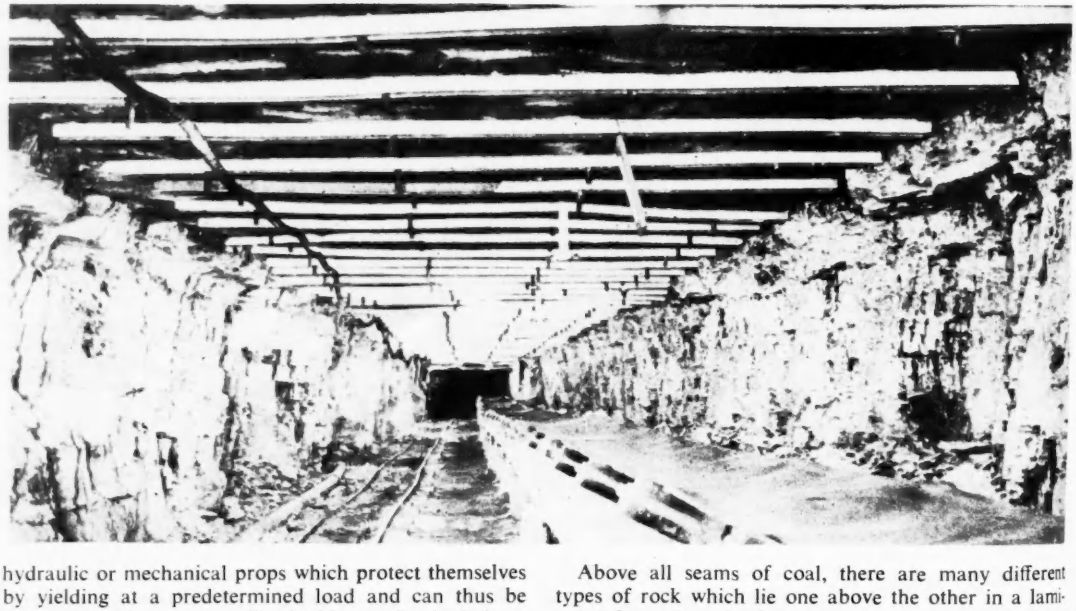


FIG. 1 (*above*). Conventional method of roof support in mines. FIG. 2 (*below*). Strata bolting.



hydraulic or mechanical props which protect themselves by yielding at a predetermined load and can thus be used many times over. On highly mechanised faces where high-speed power loading machines are in use even supports of this nature are being replaced by powered support systems which can be advanced with little or no manual effort.

From a purely engineering point of view, however, the most interesting technique for supporting the roof in mine roadways, and to a limited extent on the coal face, is that of strata bolting which uses the self-supporting properties of the immediate strata above the coal seam and maintains it in the least broken condition.

Above all seams of coal, there are many different types of rock which lie one above the other in a laminated formation. In their natural state these rocks have a certain inherent strength; the operation of mining coal, however, leaves a cavity beneath them which causes them to sag and redistributes the natural stresses. To oppose this sagging of the strata, rigid supports are usually set between the roof and floor, and in most conditions found in this country these tend to distort badly and break up both roof and floor strata (Fig. 1), with a consequent high cost in maintenance work to keep the roadways open for the ventilation of the mine and for the transport of coal and supplies.

Strata bolting has been described as a suspension system of support; that is, weaker beds of rock are suspended from stronger upper beds—but it is now generally accepted that the principle behind the system is that of reinforcement of the rock beds. High-tensile steel rods or bolts which are on an average 5 feet in length and $\frac{3}{4}$ or 1 inch in diameter are inserted in holes previously drilled normal to the natural bedding planes of the roof strata. These bolts have at one end an anchorage device which can be expanded mechanically, by percussive means, or hydraulically, after the bolt has been installed in the hole. At the opposite end of the bolt is a screwed thread which takes a bearing plate and nut. The bolt, when first installed, is anchored securely at the upper end of the hole; the bearing plate is then placed over the threaded end and is tightened to the roof by means of the nut. The effect of this tightening is to tension or prestress the bolt, and at the same time the various laminations or layers of rock are drawn tightly together to form a composite beam so that their combined strength is greater than when they are acting separately. In addition, the friction between the bedding surfaces of the various layers of rock is substantially increased, a fact which is of value when bolts are used to reinforce the floor strata in a mine roadway. The beam formed is analogous to the reinforced concrete beam widely used in civil engineering.

With this system of support, when the roof beds subside the reinforced beam subsides uniformly, there being no rigid strut to impede the inevitable downward movement and thus no break-up of the strata (Fig. 2). The origin of this method of support is somewhat obscure. It has been said that a system of this nature was practised in the tin-mines of Cornwall many years ago and that rods made of hickory wood were used to support the roof in the slate mines of Wales. It has not been possible to substantiate these reports, but there is evidence that bolts were used in Pennsylvania in the United States of America between 1880 and 1890. In 1907 the roof at a mine at Alabama was supported by drilling $1\frac{1}{2}$-inch vertical holes in the roof. Then tamping-bags filled with stiff cement were driven to the backs of the holes; cotton waste was wrapped round the rod to prevent leakage of the cement, and then pointed, $1\frac{1}{4}$-inch diameter steel rods were driven into the cement sludge. The protruding bolts were hooked to support steel cross bars.

The first full-scale strata bolting installation in the coal mines of Great Britain began in about 1951, and since that date many thousands of yards of roadway have been supported in this manner. The system is also widely applied in the iron ore mines of Britain. This method of support has many advantages over conventional systems of roadway support, although mining engineers acknowledge that it is not always applicable. An advantage is that one week's supply of bolting material can be transported into the workings in the same time that it takes to transport one day's supply for a conventional system. There are also certain economic savings in the cost of labour and materials.

RIDDLES OF EASTER ISLAND

Dr Alfred Metraux, probably the world's leading authority on Easter Island, whose new book has just

Described by Dr Metraux as the finest of all Easter Island statues, this figure of Hoa Haka Nana Ia came from the sacred village of Orongo. Brought to England by H.M.S. *Topaze* in 1869, it was presented to the British Museum by H.M. Queen Victoria. (*Copyright British Museum.*)

been published,* makes it quite clear that the problems of the origin of the Easter Islanders and the giant statues on the island are no longer mysteries.

On the subject Dr Metraux has seen the land, talked to the people, and compared all this with everything which he has been able to discover among the writings of earlier visitors to the island. In presenting his work in a popular form he has remained the scientist with a sense of order and a feeling that his work is not a final answer to the problems raised. Nevertheless he makes it quite clear that the major problems of the origins of the Easter Islanders and the reasons for the giant statues are solved.

There is not the least remaining doubt that the Easter Islanders were Polynesians. Their longer skulls link them with an earlier wave of Polynesian population than that which resulted in the rounder heads of the people of Western and Central Polynesia. Dr Metraux brings very cogent evidence that the first settlers led by the chief Hotu Matua came from the Marquesas Islands. There is much in favour of this, especially as the Marquesans had a style in wood sculpture which was much more like the Easter Island statues than their ancient stone carving. It may be that Dr Metraux's dates, which are those agreed within quite close limits by most anthropologists who have written on Polynesian affairs, may have to be somewhat altered by the discovery of new data from excavated hearths which have yielded material for carbon–14 dating. Published material makes it clear that human occupation in the Western Polynesian area may be as early as the second century A.D., and it seems likely that unconfirmed dates for Easter Island may turn out to be of the sixth or seventh century A.D. (which is in accordance with some of the Marquesan genealogies).

Of the giant statues there are enough historical legends surviving to make it clear that they were burial memorials to ancestors of the Easter Islanders, and that they stood over the sacred repositories of the bones of their fellow tribesmen. Dr Metraux describes the simple stone tools with which they were quarried, and gives a convincing description of the Polynesian system of communal work linked to festival banquets, which supplied the man-power for their transport. The material side of transport was fibre rope and hauling by main force. Some legends tell of lubricants of sweet-potatoes and yams. There is also a tradition of roads being cleared for the statues, and of pieces of wood and stone balls being used as rollers. With little useful wood on the island, and not a great deal of driftwood there must have been great economy in this precious material. However, when a statue was to be erected levers were used, and for every few inches of lift, chocks of stone blocks were put under the back of the figure. Thus inch by inch the ten tons or less of sculpture in soft volcanic tuff could be erected. It was not a terribly difficult task, but costly in time and festival food and drink for the workers.

Another problem of Easter Island, of which the solution is foreshadowed by Metraux, is now reaching its conclusion. The tablets with their curious script are in process of being read. Dr Barthel in Germany has progressed with his new material from the papers of Bishop Jaussens, and the Russian linguists who have been doing team research on the subject have interpreted phrases which agree with Barthel's work. It is best to describe the Easter Island tablets as abbreviated texts in hieroglyphic-syllabic writing. The god Tane is shown as the high god of the island, which is to be expected as it was a manifestation of Tane whom the islanders worshipped as Makémaké the bird god.

* "Easter Island: A Stone Age Civilisation of the Pacific." Trans. from the French by Michael Bullock. *André Deutsch, London, 1957, pp. 249, 21s. net.*

DRUG RESISTANCE IN MICRO-ORGANISMS

The dramatic progress made possible by the use of chemotherapeutics in the fight against infectious disease has done much to alter the pattern of world health in recent years. However, this hopeful picture is in part marred by the problem of drug resistance. Organisms which are sensitive to a drug may in time acquire resistance to that drug, and this acquired resistance may be transmitted to the progeny; so that long-term control of these infective organisms may be very complex. For instance, reports on the number of penicillin-sensitive organisms which have developed resistance are impressive, even though these penicillin-resistant organisms may in turn prove to be sensitive to other antibiotics.

The mechanisms by which drug resistance is developed are not well understood, and so far the subject has been controversial. One school of thought maintains that resistance arises as a result of genetic factors, and the other that it arises as a result of physiological adaptation. Both points of view were fully discussed recently when a small international group of scientists, prominent in this field of research, met at a Ciba Foundation Symposium in London. Sir Charles Harington, Director of the National Institute for Medical Research, was chairman, and members included research workers from Belgium, Denmark, France, Hungary, Italy, Poland, the U.S.A., the U.S.S.R., and Britain.

The theory that genic mutations is responsible for resistance received the greater support. Sir Cyril Hinshelwood and Dr Dean of Oxford, while not denying that structural mutations leading to increased resistance do occur, held the view that drug resistance arises mainly as a physiological adaptive change, and that these adaptive changes are reversible, although their reversal does not occur readily. Dr Demerec of New York, and Prof. Lederberg of Wisconsin were among those who favoured the genetic concept; and also Dr Davis of New York, who discussed changes in the permeability of bacterial cells as a factor in drug resistance. Prof. Cavalli-Sforza of Milan explained his results on acquired streptomycin- and chloramphenicol-resistance as being due to genetic adaptation, which he defined as selection of spontaneous mutants.

An attempt to reconcile the different theories on the problem was made by Prof. Yudkin of London, who proposed that the different mechanisms of resistance may occur in a single system and that the difference in theory is a result of difference in experimental approach.

Prof. Kossikov of the U.S.S.R. described details of his

experiments where he induced changes in yeasts, enabling them to adapt to fermentation of certain sugars. He said that his data showed that induced mutational changes may be obtained by the use of a specific substrate, and that these changes were inheritable, and he related them to evolutionary development.

Prof. Knox of London recalled the case of tuberculosis as exemplifying the dangers associated with the development of drug resistance, where the initial success with streptomycin would have been followed by failure, had not the antituberculous properties of *p*-aminosalicylic acid been recognised. He discussed his recent work on patterns of resistance in cultures of the tubercle bacillus *Mycobacterium tuberculosis*. While believing that the genic theory of acquired resistance was true in most cases, Prof. Kunicki-Goldfinger of Wroclaw described some physiological reactions of bacteria which seemed to be non-genic and which lead to increased resistance.

When a sensitive bacterial cell mutates and acquires resistance to an antibacterial agent, an interval of time will elapse between the occurrence of mutation and the actual expression of resistance by the cell. This interval is known as "phenotypic lag" and varies according to the mechanism of resistance. Studies on the kinetics of phenotypic expression were described by Dr Hayes of London. Some aspects of chemical mutagenesis were discussed by Prof. Westergaard of Copenhagen and by Dr Alexander of London. Prof. Frederic of Liége brought up the subject of colicins. These are a group of highly specific antibiotic substances which are produced by certain bacteria. They are protein in nature, have a high molecular weight, and can kill sensitive cells. He dealt in particular with the occurrence of mutant cells which are immune to the action of colicins.

A great deal of intensive research remains to be done before the practical problems of drug resistance will be solved. The most significant outcome of the Symposium at the Ciba Foundation was the creation of a better understanding between the two opposing schools of thought, leading to a deeper appreciation of the differing points of view.

RESEARCH EQUIPMENT IN COTTON WOOL

Stocks of unused, yet excellent, scientific research equipment are almost certainly locked up and forgotten in many a university laboratory. Since a change in university professors very often leads to a complete reorientation in research, the research equipment valued by a predecessor is often automatically stocked away by a successor. Indeed it is often most carefully preserved—and equally, most certainly forgotten. About thirty years ago there was found in the Bursar's safe at Manchester University a box which, when opened, was discovered to contain a fine large metal concave grating, made by Rowland, and inscribed as a personal presentation to Sir Arthur Schuster. Schuster had resigned the Chair in Physics at Manchester in 1907, that is, twenty years before the find. This fine grating, when reinstalled proved to be a valuable tool for research.

Not all fine pieces are so completely forgotten as this one, yet there must be relatively extensive hoards lying in cotton wool. For one is not in the least surprised to find that if, say, a spectroscopist is replaced by a nuclear physicist, then the lenses, prisms, gratings, and so on, valued by the former, might well fail to be accorded their due respect by the successor. In consequence these valuable items are tucked away, very carefully, no doubt, but in due course forgotten.

Early pieces are by no means obsolete when compared with more recent equipment. Any optical instrument-maker today would be hard put to it to produce a better Lummer plate interferometer than one made in 1935: a plate 20 centimetres long, cut from an exceptionally perfect quartz crystal only $3\frac{1}{2}$ millimetres thick, yet accurately worked to be plane and parallel to within an *eightieth* part of a green light-wave. The skill, patience, indeed the artistry, which went into its construction is not at command today, even at ten times the original price. Frequently experienced microscopists swear by some beloved old microscope objective which, they insist, has no peer among modern lenses.

In physics alone, lenses, magnets, gratings, and specially designed pieces of equipment, all still eminently usable in serious research, must certainly be lying locked in cupboards. It may be different in the chemical and biological sciences, since so much of the equipment is demountable or convertible or indeed too fragile for transfer. Yet refractometers, polarimeters, and manometers may also be snugly tucked away, and we know of one magnificent precision goniometer recently acquired by an eminent scientist from such a source.

Some responsible scientific body ought to undertake a national survey in our universities by means of detailed questionnaires to heads of laboratories. All laboratories must have fairly full inventories, if only for insurance purposes. The amount of labour involved in any one laboratory in tabulating and in describing the few valuable pieces which it might own and for which it can predict no foreseeable use, must be relatively small. Clearly the obsolete material which accumulates in every laboratory does not matter, but only the *valuable* items. A central body could co-ordinate the information and produce a comprehensive classified list which could then be circulated to all university laboratories. By this means the existence of the redundant equipment would become widely known. *All* universities could be expected to co-operate in consenting to loans being made of such equipment, under satisfactory safeguards.

Probably much of such unwanted research equipment finds its way either into the elementary teaching laboratories, or is broken down for components. Neither procedure is economic, and both may sometimes be deplorable. The story goes that someone was once using a "nicely cut" although scratched block of glass as a paper weight. It was identified as the first Lummer plate interferometer to have been made in Berlin! Such tragic endings for historic pieces are undoubtedly the exception rather than the rule. Yet surely every professor would welcome a more worthy and more active home for fine equipment than a carton carefully packed with cotton wool.

DEW RESEARCH FOR ARID AGRICULTURE

Sh. DUVDEVANI, Ph.D.

Director, Dew Research Station, Karkur, Agricultural Research Station, Rehovot, Israel

In July 1956 one of the first two Rothschild prizes "for original research in science which will have a constructive bearing on the life of Israel" was awarded to Dr Sh. Duvdevani for pioneering work in dew research. By demonstrating that dew benefits plant-growth, that in plants water moves downward from leaf to root as well as from the soil upward, he demonstrated the validity of the Biblical association of the "dew of Heaven" with the "fatness of the earth and plenty of corn and wine". (Genesis xxvii, 28.)

Many sleepless nights were devoted to the painstaking and complicated task of observing and recording before sunrise the formation of dew on plants and other natural substrata. The first hint that it was all worth while came from numerous exciting references to dew in the Bible and other classical Hebrew writings. The story of Gideon, for instance (Judges vi, 36–38), contains the earliest known reference to an attempt to measure the amount of dew absorbed by wool. The Hebrew liturgy contains regular daily prayers for dew in summer and for rain in winter.

THE DEW-GAUGE

Palestine is peculiarly suited to field experiments on dew and its influence on plants. From early June until mid-September there is absolutely no rain, though there is a marked dewfall on summer nights.

The basic problem of determining the quantitative significance of dew in relation to its deposit on plants was solved several years ago by the invention of a simple easily read dew-gauge which has become a standard instrument for use in measuring dew. This consists of a standard-sized wooden block, specially treated and painted, which serves as a uniform base for dew-deposits. Dew forms on the gauge during the night in certain patterns. Each pattern is characteristic of a certain amount of dew and is identified by comparison with standard dew photographs, comprising the Dew atlas.

The varying patterns of dew-drops on the dew-gauge, their size, shape, and distribution had led to the establishment of a scale of values, expressed in fractions of a millimetre.

The Palestine (now Israel) Meteorological Service helped to set up a network of dew-stations in various parts of the country. They have been giving dew readings for ten years at an agreed height of one metre above ground. It was found that dew is a steady climatic element in Israel, with minimum and maximum seasons well defined in every district, different districts and sub-districts having their own types. Topographical influences, the structure of the soil, vegetation, and irrigation can alter the quantities of dew at a certain spot, but not its *relative* monthly distribution. In most districts dew is more frequent in summer than in winter and is very common even in the hot Jordan Valley.

FIG. 1 (*left*). The oldest known method of measuring dew-fall. This fleece is similar to the one used by Gideon the Judge to prove that he was chosen by God to lead his people against the invaders. "Behold, I will put a fleece of wool on the floor; and if dew be on the fleece only and it be dry upon all the earth beside, then shall I know that thou wilt save Israel by mine hand, as thou hast said."
FIG. 2 (*right*). Gideon's ancient experiment repeated by Jael Duvdevani at harvest time on the primitive threshing ground of an Israeli village. Jael "thrusts the fleece together and wrings the dew out of the fleece into a bowl full of water".

FIG. 3. Duvdevani dew-gauges at sunrise. These three were placed at different heights, the one on the left with the lowest dew-deposit being the one which was originally nearest the ground. This vertical dew distribution is typical for summer arid conditions.
FIG. 4. Dr Shemuel Duvdevani examines dew formation on a set of Duvdevani dew-gauges early in the night. The set of gauges show the dewfall at different heights above the ground.

Various countries interested in systematic dew observations and their relations to plants are also measuring dew by means of the "optical method" with the aid of the Duvdevani dew-gauge (and dew-atlas), approved many years ago as a standard instrument by the World Meteorological Organisation.

It was seen that the higher the value of the dew-deposit on the gauge, the greater the area of the foliage covered by dew, the greater the quantity of dew on every unit of the plant surface and the longer the hours of dew duration on the plant. The more extensive and intensive the dewing, the more extensive and intensive its absorption by the plant. Regular dews keep the bedewed foliage wet in field crops for at least three to five hours after sunrise—even in dry summer—which is one of the reasons why these are the best hours for photosynthesis in an arid country and therefore of great importance for farmers in arid regions.

NATURAL AND ARTIFICIAL DEW

Field observations led inevitably to many fascinating experiments in the potential utilisation of natural dew and dew-imitating artificial spray. It was found that dew could be used partly to restore wilting leaves of

TABLE

Dew distribution, summer and winter, in various parts of Palestine

Station	April-Sept.		October-March		Annual	
	Total (mm.)	No dew nights	Total (mm.)	No dew nights	Total (mm.)	Number of dew nights
COASTAL PLAIN:						
Mt Carmel, Haifa	23·7	127	5·3	48	29·0	175
Tel Shalom, Karkur	21·0	151	9·2	81	30·2	232
Beer Tuvia	10·6	97	9·6	63	20·2	160
Lod Airport	9·7	111	15·7	89	25·4	200
Sabinia	21·0	142	10·0	71	31·0	213
Gevulot (previous location)	16·7	134	12·7	89	29·4	223
HILL REGION:						
Manara	17·1	80	5·9	37	23·0	117
Ramalla	16·0	88	11·4	66	27·4	154
Jerusalem (exposure not ideal)	11·2	76	10·4	69	21·6	145
Mishmar Haemek (loom)	16·7	140	11·7	87	28·4	227
JORDAN VALLEY:						
Degania	4·8	97	8·8	74	13·6	171
Beit Alpha	3·2	81	7·4	75	10·6	156
Jericho	0·4	26	4·3	89	4·6	115

thirsty plants, and this is more efficiently obtained by a process of "dew irrigation" sprays. This spraying succeeded in bringing full recovery to wilting citrus-trees which had been neglected and not irrigated for many rainless summer months and some of whose branches were brittle with dryness. The formation of new leaves on vegetables "watered" with natural or artificial dew is much greater than on the unsprayed ones (controls); their rate of growth is faster and they yield a bigger crop. The effect is especially pronounced under conditions of low soil-moisture. Cucumber plants under moisture stress have improved their growth by 50% in comparison with plants on unbedewed plots used as controls.

In one experiment, leaves of various plants were cut off at sunset, the stem ends being sealed with paraffin and the leaves exposed to dew, while in the control test the leaves were freely exposed, but below a slight canopy to keep off the dew. At sunrise the bedewed leaves were fresh but the unbedewed ones more or less withered.

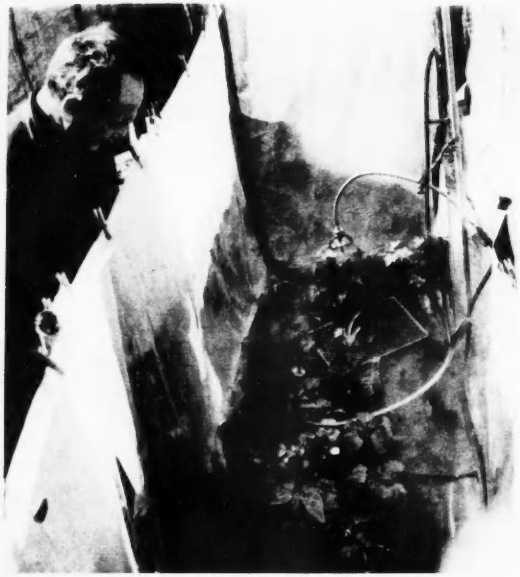
Intensity of night recovery for corn plots and fields has been studied. It was established that night recovery from daily wilting is quicker and better with bedewed plants, being specially pronounced under heavy dew nights. Corn and sorghum are widespread summer crops grown with and without irrigation in many arid countries. Growth of such non-irrigated crops is the best in dew-rich areas.

MECHANISM OF DEW ABSORPTION

It was now possible to attempt some understanding of the mechanism underlying these observations. Life-supporting water can move from the leaves downward as well as upward from the soil. This fact sheds new light on the water economy of plants and introduces into plant physiology the concept of a two-way traffic in water supply. Previously it had been thought that the water used by plants travels only in one direction—upward from the roots to the leaves.

Not only do wetted leaves absorb water, but the liquid moves through the full plant system down to the roots and may even be excreted by the roots. Thus dew con-

FIG. 5. Dew formed on Sorghum leaves.



densing during the cool of the night can be stored in the soil immediate to roots and made available the next day when photosynthesis begins under the influence of sunlight.

The first evidence for these conclusions came from years of open-air field experiments. Soil mixture was found to be about 1% higher for young pot-grown plants of corn and beans that received dew as compared with the unbedewed. During appropriate heavy-dew- and growth-seasons water droplets could be seen quite frequently on the roots of certain plants (Bermuda-grass, morning glory, a mulberry-tree, etc.) which were made visible in specially excavated soil trenches.

Repeated field observations during the dry season led to controlled laboratory experiments. Being invited to work as an Institute Research Fellow by the California Institute of Technology, I was able to check our field findings in Israel under the most highly controlled conditions and in a disease- and pest-free environment at the unique Earhart Plant Research Laboratory (Director-Prof. F. W. Went). Here work was carried out with partly wilted specimens of tomato, bean, cucumber, water-melon, Brussels sprout, sugar beet, Coleus, and corn plants. Their roots were sealed in empty glass jars, or in containers with soil, a careful check being kept on the sealing materials to ensure that no leakage occurred. Their tops were exposed to water spray for eight to ten hours, primarily at night to simulate dew as closely as possible, or to continuous day and night spray.

The first sign of benefit from the spray was a gradual recovery from wilting in all the test plants. Experiments in which only a portion of the exposed plant top was sprayed showed that after the wetted parts became firmer and greener, the unmoistened parts recovered also. And whereas the wilting treatment which they had undergone before spraying had dried out some of the

FIG. 6 (*top left*). The author examines the special "shower bath" he has set up in the grounds of his home. The plants here have had their roots sealed and obtain all their moisture through their leaves, from the spray which forms an artificial dew. The plants seem to thrive on the treatment, even when embedded in supposedly arid soil.

FIG. 7 (*above*). The author examines the roots of a plant which is sealed so that it can obtain moisture only through its leaves. Some of these plants absorb more moisture through the leaves than they need, and exude the excess water through their roots, where it can be seen through the plastic container.

FIG. 8 (*below*). The author weighs a plant whose roots have been sealed off and which obtains water only through its leaves. This periodic weighing shows the net gain from foliar water intake in excess of transpiration loss for the given spray hours.

FIG. 9. Mrs Duvdevani takes temperature, rainfall, and other weather readings in the grounds of the cottage at Karkur. These meteorological data are correlated with dew readings. Rainless spells "compensated" by regular dew nights are compared with droughts with no dew. Comparative possible effect on plant life is studied.

roots, new roots now started to develop in great numbers. Clearly, water absorbed by the leaves was travelling through the plants.

Striking evidence that it was moving downward and even out of the plants came when exudation droplets formed on actively growing roots. This usually happened two or more days, and never less than one, after the spraying began. The plants apparently used the available water first for their recovery. After their immediate needs were satisfied, they continued to take in water but gave off the excess into the immediate vicinity of their roots.

As time passed, water accumulated in the containers under conditions of continuous spray in appreciable amounts. Seedlings of tomato and young corn plants were especially active, sometimes excreting water many-fold their own fresh weight during one week or so. In some cases water stopped accumulating after a few days; in others it continued for several weeks in quantities that varied from day to day.

In order to avoid a confusing complexity in the initial experiments no additional nutrients were given to the plants during the spray treatment, but shoots continued to grow normally while their food reserves permitted. As their stored nutrients were used up the plants declined. Only in two experiments, one with tomatoes and another with beans, were single fruits obtained.

In Israel today, research continues at the Dew Research Station, Karkur (now part of Rehovot Agricultural Research Station) under the watchful eye of my family—for my wife and daughters have been devoted assistants since the early pioneering experiments.

It is already evident that dew may be a deciding factor under critical drought conditions when even a small contribution towards the plant's water economy can determine whether a plant dries up or lives through a dry spell.

Further study is expected to show how much of a plant's water requirements can be contributed by dew, and what types of plants can use dew or foliar spray most advantageously, what are the specific morphological and physiological effects of foliar water-intake, and in what environment and stage of their development foliar water-intake is most effective for those plants.

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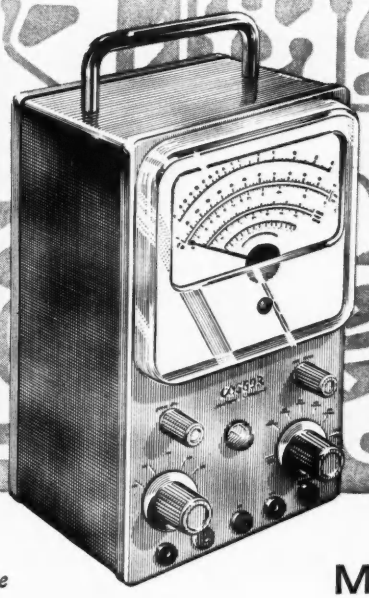

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METEORITES

JOHN S. RINEHART

Smithsonian Astrophysical Observatory, Cambridge, Massachusetts

Meteorites are bits and pieces of extraterrestrial stony and metallic matter that have survived the rigours of their passage through the Earth's atmosphere. Because they are our only ponderable extraterrestrial material, they are assiduously collected, carefully examined, and critically analysed.

HISTORICAL

The science of meteorites was born in 1803, when scientists first officially recognised that stones can in fact fall from heaven. Before the 19th century we have accounts of stones that were believed to have come to us in such a way, among them the Black Stone of the Mohammedans at Mecca. Scientists remained sceptics. They contended that such stones were of terrestrial origin: formed by lightning strokes, thrown out of volcanoes, or condensed from vapours in the atmosphere during thunderstorms. A tremendous fall of stones occurred at Laigle, France, in 1803, however, so great that even the staid French Academy was forced to admit that the stones could not have had a terrestrial origin.

It is now well established that extraterrestrial matter of three distinctly different origins reaches our Earth: solar-system dust, which is drifting through all the solar system and with which the Earth collides; meteors, which are debris from comets; and meteorites, which are fragments of disintegrated asteroids or small planets.

FIG. 1. Heavily ablated front face of Cabin Creek, Arkansas, iron meteorite. The deep circular pits are the direct result of violent scouring action of air during flight. The meteorite is discus-shaped and weighs 107 lb. Note 30-centimetre rule with centimetre scale in foreground. (*Photograph by the author.*)

The flight through our atmosphere of a meteorite, and its subsequent and violent interaction with our lithosphere; the composition and internal structure of a meteorite; and its extraterrestrial life, are all topics of special interest. A wide diversity of technologies—astronomy, astrophysics, physics, chemistry, mineralogy, and metallurgy—play important rôles in our studies.

PHENOMENA INCIDENTAL TO FALL

The flight of a meteorite through our atmosphere is a spectacular event. It is not nearly so spectacular in this age of jet aircraft as it must have seemed years ago when our skies were not continually spotted with vapour trails and the crack of a shock-wave was not a common event.

Two swarms of large metallic meteorites have fallen in recently recorded history. Both were in Russia. The Tungusta fall of 1907 levelled trees over an area of a 30-mile radius and produced barometric effects that were detected round the world. The Sikhote Aline fall in 1947 likewise wrought great havoc.

The Laigle fall of stony meteorites in 1803 was described by the scientist Biot in Tilloch's *Philosophical Magazine*.* This exact account settled the question of the extraterrestrial origin of meteorites.

"On Tuesday, April 26, 1802 [*sic*], about one in the afternoon, the weather being serene, there was observed from Caen, Pont-Audemer, and the environs of Alençon, Falaise, and Verneuil, a fiery globe of a very brilliant splendour, which moved in the atmosphere with great rapidity. Some moments after there was heard at Laigle, and in the environs of that city to the extent of more than thirty leagues in every direction, a violent explosion, which lasted five or six minutes. At first there were three or four reports like those of a cannon, followed by a kind of discharge which resembled a firing of musketry; after which there was heard a dreadful rumbling like the beating of a drum. The air was calm and the sky serene, except a few clouds, such as are frequently observed.

"This noise proceeded from a small cloud which had a rectangular form, the largest side being in a direction from east to west. It appeared motionless all the time that the phenomenon lasted. But the vapour of which it was composed was projected momentarily from the different sides by the effect of the successive explosions. This cloud was about half a league to the north-north-east of the town of Laigle: it was at a great elevation in the atmosphere, for the inhabitants of two hamlets a league distant from each other saw it at the same time above their heads. In the whole canton over which this cloud hovered, a hissing noise like that of a stone discharged from a sling was heard, and a multitude of mineral masses exactly similar to those distinguished by the name of *meteoric stones* were seen to fall at the same time.

* Biot, C., *Phil. Mag.*, 1803, vol. 16, p. 224.

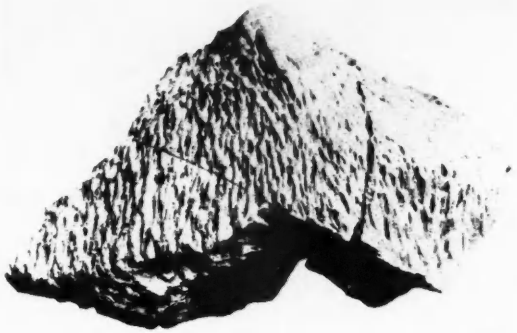

FIG. 2 (*left*). Large, severely ablated, stony meteorite, Long Island, Kansas. Weight of meteorite, 1200 lb. Diameter, approximately 25 inches. It broke on hitting the ground. Note the conical shape. The nose is smooth, but farther back deep furrowing sets in. (*By courtesy of the Chicago Natural History Museum.*)

FIG. 3 (*right*). Polished and etched cross-section of stony-iron Brenham, Kansas, meteorite. The dark patches are stony olivine. The Widmanstatten pattern is very distinct. Section about 8 inches across. (*By courtesy of the American Museum of Natural History.*)

"The district in which the stones fell forms an elliptical extent of about two leagues and a half in length and nearly one in breadth, the greatest dimension being in a direction from south-east to north-west, forming a declination of about 22°. This direction which the meteor must have followed is exactly that of the magnetic meridian; which is a remarkable result.

"The largest of these stones fell at the south-east extremity of the large axis of the ellipse; the middle-sized ones fell in the centre, and the smallest at the other extremity. It thereby appears that the largest fell first, as might naturally be supposed. The largest of all those which fell weighs 17½ pounds. The smallest I saw weigh about 2 gros, which is the thousandth part of the former. The number that fell is certainly *above* two or three thousand."

We know, now, from the number of shock-waves or "explosions" felt by the observer, that the meteorite broke into four large pieces on striking dense atmosphere at low levels. Break-up is the usual fate, particularly of a stony meteorite.

The dense, persistent trail is also typical of a fall. The trail is partially vapour, but mainly a column of debris removed or ablated from the surface of the meteorite by the intense heating and violent scouring action of the air. The pitted surfaces of many recovered meteorites are ample proof that much material has been ablated.

It is not clear how the meteoritic material ablates. Extreme pressures and temperatures exist at the velocity a meteorite travels. Removal of material is rapid at these extreme conditions. Vaporisation, melting, flaking, or mechanical destruction are all possible, and undoubtedly all these processes take place but in varying and unknown degree. It is generally assumed that the rate of mass loss will be proportional to the rate at which work is done in decelerating the meteorite. The efficiency of energy transfer in this case is low, and probably not more than 1% of the energy available is used in removing the material. Best estimates are that a large, 1000–2000-lb. meteorite will lose one-half to one-third of its mass during transit through the atmosphere.

The velocity with which a meteorite can enter our atmosphere ranges from 7 miles/sec. to 44 miles/sec. The lower limit is the escape velocity of a body from the Earth; that is, the velocity that a meteorite would acquire in falling towards the Earth under gravitational attraction, should the Earth and the meteorite suddenly find themselves beside one another with zero relative velocity. The upper limit arises from the fact that meteorites are members of the solar system; to be a member of the solar system a body must not have a velocity greater than 26 miles/sec. when its distance from the Sun is that of the Earth. The Earth's velocity about the Sun is 18 miles/sec. Thus, if the Earth and a meteorite travelling at maximum velocity strike head-on, their relative velocity will be 18 miles/sec. plus 26 miles/sec., or 44 miles/sec. Observations indicate, however, that the velocity of most meteorites is about 10 miles/sec.

Because of the retarding action of the air, the velocity with which a meteorite actually strikes the surface of the Earth is usually quite low, a few hundred feet per second. It is easy to visualise this considerable deceleration in terms of penetration through water: the total air mantle is about equivalent in weight to 30 feet of water. Only occasionally a large meteorite, heavier than 1000 tons, will enter and not be appreciably retarded. Small, low-velocity meteorites either bury themselves in the ground to a depth of a few inches or feet, or ricochet to lie finally on the surface of the ground. The high-velocity meteorites produce craters whose size is very much larger than the meteorite itself. This fact is illustrated by the great Arizona Meteorite Crater, where a crater 4100 feet in diameter and 600 feet deep was dug by a meteorite whose diameter was probably only 50 feet. There are about a dozen large craters or groups of craters on the Earth that are definitely identified as of meteoritic origin.

Fragments of metallic meteorites are usually scattered

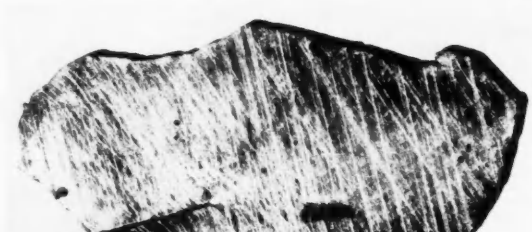

FIG. 4. Polished and etched cross-section of hexahedrite, Coahuila, Mexico. The black line is a 1-inch scale. Neumann bands (scratch-like appearance) are prominent. (*By courtesy of the American Meteorite Museum.*)

about these craters. Many attempts have been made to establish other craters as meteoritic, whether or not meteoritic debris is present.

NUMBER, SIZE AND FORM OF METEORITES

How many meteorites strike the Earth per year? How much extraterrestrial material does this represent? There are no satisfactory answers to these important questions. One writer estimates that five or six meteorites per day strike the Earth. This figure is based on a fairly reliable count of the number that fall within the central region of the United States. The average recovered mass per fall is 20 kilograms. (*See* Watson, "Between the Planets", 1956.) Assuming the average weight of each meteorite to be 100 kilograms before it enters the atmosphere, and allowing for loss suffered in the atmosphere, we may conclude that the total accretion per year is about 200 tons, about half a ton per day.

Curators of museums persistently collect, painstakingly describe, and proudly display their meteorites. Large collections have been built up, principally by the National Museum of the Smithsonian Institution, Harvard University, Yale University Museum, Chicago Museum of Natural History, American Museum of Natural History, New York; American Meteorite Museum, Sedona, Arizona; British Museum of Natural History, London; Natural History Museum, Vienna; and Museum of Natural History, Paris.

Meteorites are acquired in two ways, as falls or finds. As falls, they are actually seen in the act of falling and the observer or his fellow-searchers are able to recover them. If meteorites are stumbled upon *in situ*, recognised for what they are, and saved, they are designated as finds. The total number of falls and finds is listed in the table. A particular fall or find may comprise a number of individual meteorites. For example, more than 20,000 stones were recovered from the Holbrook shower, which is regarded as a single fall. The ratio of falls to finds is high, 2·1 for stone, and low, 0·1, for irons. The numbers of falls of stones and finds of irons are high for several reasons: stones ablate more readily than irons, and thus their trails are more likely to be seen; once a stone has fallen, however, it is not always readily distinguishable from terrestrial rock. On the other hand, a stray chunk of iron lying in a field is more likely to attract attention, even though its arrival was unheralded.

Meteorites range in size from the Hoba West, 70-ton, massive chunk of nickel-iron, which has never been moved from its resting-place on the surface in South Africa, to stones obtained from showers such as the Holbrook, the size of peppercorns.

Occasionally a shower of stones falls. It may contain as many as 1,000,000 stones, ranging in size from peas to 20- to 30-pound chunks. These pieces probably result from the disintegration of the stony meteorite after it has entered the Earth's atmosphere and they may be scattered over an elliptical area as large as three or four miles long and two miles wide. The best-known large irons are those that Admiral Perry brought back from Greenland in 1905 with so much effort. The largest of these weighed 34 tons.

A recovered meteorite can have almost any shape. This shape is only partly representative of its extra-terrestrial form. Many freshly fallen irons and stones show intense sculpturing by the air: small (up to 3 inches in diameter) meteorites are smoothly sculptured; large stones exhibit shallow elongated pits or depressions (1 inch long by $\frac{1}{2}$ inch wide by $\frac{1}{4}$ inch deep); and large irons show very deep pits (2 inches in diameter and 1 inch deep). There may be gross break-up of the meteorite during flight, or deformation and break-up on impact, although many show no impact scars.

Every freshly fallen stone is coated with a thin layer about $\frac{1}{16}$ inch thick of vitreous material which is undoubtedly fused stone of the meteorite. The melting took place during flight. Irons are more subject than stones to weathering after having landed; they oxidise and corrode slowly, flaking away with time.

COMPOSITION AND STRUCTURE OF METEORITES

Meteorites are divided into three general groups on the basis of their structure and composition. The irons or siderites are dense metallic masses composed princi-

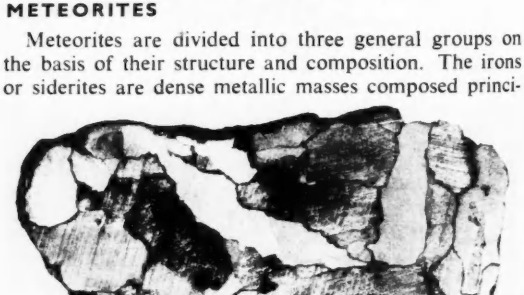

FIG. 5. Polished and etched section of brecciated hexahedrite, Sandia Mountains, New Mexico. About 5 inches across. An aggregate of hexahedrites. The bright, shiny scratch lines are Neumann bands. (*By courtesy of the Smithsonian Institution.*)

pally of nickel and iron. The aerolites have a stone-like structure, although they may contain inclusions of metal in fair abundance. The third group, siderolites, is made up of approximately equal amounts of stone and iron. Sponge-like iron masses with stony material filling the interstices are called pallasites; when the metal is discontinuous, they are called meso-siderites. This third group also is quite unlike any other object we normally find here on earth. A fourth type, the tektite, which is a glass-like mass, may or may not be of extraterrestrial origin. Tektites were discussed extensively in a recent issue of this journal [DISCOVERY, 1956, vol. 17, p. 408].

Meteorites provide our best clues as to the relative abundances of elements in our solar system. Unfortunately, we do not know the relative quantity of stone to metallic meteorites that fall; stones are approximately four to nine times as abundant as metallic meteorites, whose nickel content ranges from 5% to 20% and even to 30%, the remainder being mostly iron.

Stones vary widely among themselves. Silica (SiO_2), the main constituent, ranges from 30% to 55%. Average percentages of some other constituents are Fe+FeO, 25·95; MgO, 23·66; CaO, 1·88; Al_2O_3, 2·86; Na_2O, 0·87. Stony meteorites are closely akin mineralogically to the terrestrial peridotites, intrusive igneous rocks. Peridotites, unlike meteoric stones, usually contain no unoxidised metal, but they are both sometimes diamond-bearing.

Stony meteorites have an extremely complex structure. Microscopically they appear as a mixture of fragmented crystals that are not easily identifiable. Troilite, FeS, and small pieces of metal are intermingled with these fragments. Many stones contain small roundish inclusions, called chondrules, of glassy olivine or a pyroxene. Frequently a chondrule appears to have begun solidifying from a point near its surface. Chondrules are never found in terrestrial rocks.

The key to the problem of stone-structure resides in the origin of chondrules and of the free metal, nickel-iron, which occurs in the form of veins, flakes, and grains. Simple crystallisation of a molten mass would yield neither a fragmented structure nor chondrules. The diversity and orderly variation of structure, composition, and metallic content argue strongly against the theory that the stone was first pulverised, and then subsequently mixed and compacted.

The structure of irons is a much more straightforward problem. They are obviously descendants, remnants, and in some cases aggregates of large single crystals of nickel-iron. In metallic meteorites the nickel content ranges from 4% to 30%, the remainder being mostly iron. The other main constituent is cobalt, of which there is usually about one-half of 1%.

	Falls	*Finds*	*Total*
Iron	42	503	545
Stony-iron	12	55	67
Stones	628	304	932
Total	682	862	1544

The hexahedrite, a body-centred cubic structure, is the simplest of the irons. There are two types of these: in one, the whole meteorite is a single crystal of nickel-iron, sometimes eight or ten inches through; in the other, it is an aggregation of a few or many single crystals, each frequently an inch or so through. A polished section of a hexahedrite always exhibits a criss-cross pattern of perfectly straight lines, resembling scratches. These Neumann bands are indicative of highly localised mechanical deformations, specifically twinning, within the crystal.

While a hexahedrite contains only 6% nickel, an octahedrite contains 6% to 12% nickel and is characterised by its Widmanstätten pattern, a unique and fascinating metallurgical curiosity. The pattern, after an exposed surface of the meteorite has been polished and etched, shows as a series of straight intersecting bands which are parallel to the faces of an octahedron: hence the name, octahedrite. Metallurgically the bands consist of wide patches of kamacite (nickel-poor iron, body-centred cubic crystal lattice) bounded by thin layers of taenite (nickel-rich iron, face-centred cubic crystal lattice). The areas between intersecting bands are filled with an intimate mixture of the two materials. It is easy to explain the growth of these patterns but impossible to duplicate them in the laboratory, except on a microscopic scale, because of the extraordinarily slow cooling rates required. The pattern forms as a result of transformation from one metallographic phase, face-centred cubic lattice, to another, body-centred cubic lattice. The transformation requires diffusion of nickel and an equilibrium partition of it between the two metallic phases. During the transformation the body-centred phase deposits out on the octahedral planes of the face-centred phase. At lower temperatures diffusion and transformation stop and the pattern is frozen.

A few meteorites, known as ataxites, have little identifiable structure. Some are nickel-poor, others nickel-rich.

Iron meteorites contain many inclusions, the most notable of which are diamonds. The Canyon Diablo specimens from the Arizona Meteorite Crater are said to be especially rich in these: about one small diamond per 10 cubic centimetres of meteorite. The Canyon Diablo specimens also contain large, one inch in diameter, nodules of graphite. Iron phosphide is another common inclusion. Iron sulfide, or troilite, is the most abundant inclusion and nodules of this are found in practically all iron meteorites.

EXTRATERRESTRIAL LIFE

All evidence points to the conclusion that meteorites are, without question, fragments of a disrupted small planet or perhaps of several planets. The planet was molten during part of its life-cycle. Some believe that it formed cold and became hot by radioactive heating; others, that it was molten in the beginning. The precise recipes and mixing procedures are not well understood. It would seem likely that a gravitational field, acting on

the constituents of the planet during the planet's molten stage, would separate the lighter stony mass from the heavier iron masses. The stone would rise and form the surface mantle; the iron would become the core. Between the two a layer would form of intimately mixed stony material and iron. Thus we have here the makings for all of the known meteorites.

The higher temperatures and pressures existing in the interior of the planet during the molten phase are precisely the conditions required to make diamonds such as those frequently found in meteorites.

As the planet slowly cooled, ideal conditions would exist for the growth of the large single crystals of nickel-iron that form the hexahedrites. Contraction on cooling sets up a stress, which, combined with high temperature, is an environment most favourable to the growth of iron single crystals in the laboratory. The large crystals and slow cooling also provide the starting-point for the formation of the Widmanstätten figures.

In the writer's opinion, the formation of Neumann bands is the final effect of the cooling stresses. Under static stressing, Neumann bands form only at low temperature, below -120°C, and hence the planet must have become at least this cold. Such a temperature is the equilibrium temperature of a body situated in an orbit about half-way between Mars and Jupiter, where the asteroidal belt is located. The parent planet probably lay in this belt.

Once the iron and stone matter becomes solid, any gases that are formed within it by radioactive disintegration or by cosmic-ray bombardment are trapped there. The trapped gases are our best clue to the "age" of the meteorite.

The "radioactive ages", or the time at which the planet solidified, of eight stony meteorites have been measured and they range from $3{\cdot}0 \times 10^9$ to $4{\cdot}5 \times 10^9$ years. The best and most widely adopted method of calculating age uses the potassium-argon radioactive reaction, although several other reactions can be utilised—strontium decaying to rubidium, or uranium and thorium to helium. The argon exists in minute quantities, roughly 10^{-5} cubic centimetre per gram of stony meteorite and is extracted by special microchemical gas techniques. Simultaneously the potassium content, which is much larger, sometimes as high as 0·1% by weight, is determined by neutron activation or other means.

Much less than the radioactive age is the "cosmogenic age", tentatively set at about $1{\cdot}3 \times 10^9$ years. This age is measured from the time the meteorite was first exposed to cosmic-ray bombardment; that is, the time when the planet broke up. Measuring the helium content was used first to determine the radioactive age, but the results were much in error because cosmic rays impinging on the meteorite also generate appreciable quantities of helium. It is now believed that most of the helium in meteorites is cosmogenic in origin.

The never-ending fascination in the study of meteorites lies in man's quest to solve the mysteries of his surroundings. The metallurgical, geological, and physical secrets hidden in meteorites can be unlocked only by employing a diversity of talents and technologies. Interpreting the clues to the origin and nature of meteorites will inevitably extend our knowledge of the origin and nature of the universe.

(Publication authorised by Secretary of the Smithsonian Institution.)

TWENTY-FIVE YEARS AGO

RESEARCH ON HEREDITY

An article in DISCOVERY for August 1932 reminds us of the speed at which genetic research has advanced, and yet how little we know, nevertheless, of the fundamental laws governing heredity.

"Dr John Belling [working at the Carnegie Institution in Washington] . . . has been engaged in research on the organism of inheritance believed to lie within the chromosomes which occur in the nucleus of living cells. The work has involved a study of the principles of optics as they apply to extremely high-power microscopes; a search for plants having chromosomes which could be studied to the best advantage; and the development of an improved technique in preparing chromosomes for observation. 'We wonder, on the one hand,' writes Dr Belling, 'at the great diversity of species; on the other, at the marvellous precision with which each species is reproduced. We marvel, also, at the wonderful fitness of organisms to the world in which they develop and, in turn, reproduce. It is for the geneticist to give a scientific explanation of these phenomena, to bring under general laws the isolated facts of development, of diversity, of fitness. The first great advance in the scientific explanation of these phenomena was the tracing of the development of the individual by embryologists. The next was the discovery of the mechanism by which the internal factors that control development do their work. It is because the germ plasm . . . shows a continuity that the species reproduces itself. It is the failure of the former germ plasm to continue to reproduce itself in the same way that is responsible for genetic variation or mutation. Yet this failure is regular.

"The Easter lily, the Madonna lily, the royal lily, and the leopard or tiger lily of California, were . . . most frequently examined, but it was in the last of these that Dr Belling first observed the objects which he believes contain the genes.

"Although, according to theory, genes are present in the tissue cells of plants and animals as well as in their germ cells, it is with the latter, more particularly the pollen mother-cells of the flower buds of the lily, that Dr Belling works. He takes the anthe and presses the mother-cells of t pollen out on to a clean glass sli which he instantly immerses in a fixir solution consisting of a combination powerful chemical agents. It is impo tant that the cells should be kille instantaneously; for if they are permitted to die slowly the structures which it is necessary to observe fuse and lose their distinctive appearance. . . .

"It would seem . . . that the explanation of the various ways in which the individuals of a given species develop, whether plant, insect or man, of the peculiarities and diversities that give them individuality, and of the extraordinary resemblances and differences that exist between parent and offspring, requires the assumption that there actually exists a constituent physical entity in the chromosome which is passed from generation to generation and that this is capable of bringing about the development in the new generation of the same character which its progenitors had developed in the parent generation."

FIG. 1. Close-up of the Cicada nymph. (*Photo by Lynwood M. Chance.*)

"LA CIGALE"

J. L. CLOUDSLEY-THOMPSON, Ph.D., F.L.S.

The rival world of the insects cannot be ignored: the lively creatures press their claims too strongly upon our attention. As destroyers of food, crops, and stored produce they are a menace to mankind, and as agents for the transmission of disease all too frequently they spread misery and death among the less prosperous people of the globe. Yet the land would be dull without their ceaseless activity: the brilliance of the summer sunshine is enhanced by the beauty of their iridescent wings and metallic bodies; the charm of the twilight by their melodious chirrups and cadences.

It is to the ear rather than the eye that cicadas mostly commend themselves. True, the Romans considered their vocal extravagances to be highly unpleasant, but the Latin name *cicada* is no less onomatopoetic than the Greek *tettix* (τέττιξ). Indeed, the cicada is rooted as deeply in Greek mythology as in the literature of the Orient.

Although the great green grasshopper (*Tettigonia viridissima*) is substituted for the cicada in La Fontaine's version of the fable of "La Cigale" and the industrious ants—probably because cicadas are not common in the part of France where he lived—it is unquestionably the latter insect that Æsop indicated. In England, where the only cicada is *Cicadetta montana*, a rare species to be found in the New Forest, the cricket is sometimes portrayed as the carefree minstrel who had to beg for food when winter came. The legend evidently dates from antiquity and a version of it is found in the oral traditions of the Maori peoples.

The male cicada possesses one of the most complicated sound-producing organs in the animal kingdom

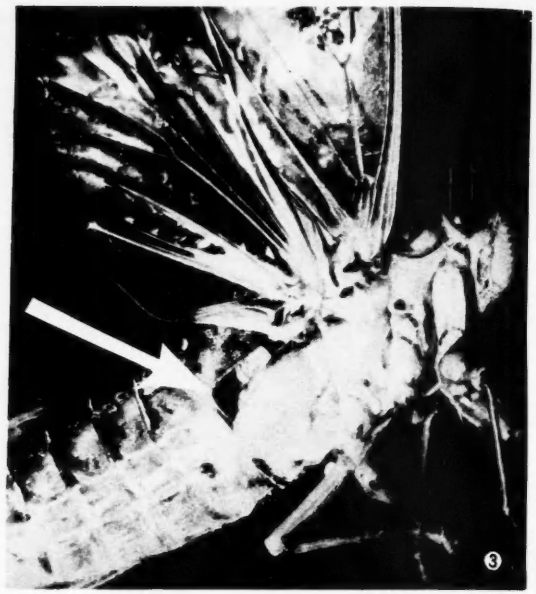

FIG. 2. *Cicada orni L.*, the common French cicada. (*Photograph by the author.*) FIG. 3. The immediate source of sound in the cigale is on either side of the anterior of the abdomen, near the thorax. FIG. 4. A cut-away showing the chitin flap protecting the sound-producing membrane, indicated by the arrow. On the right are the origin and insertion of the muscle, which vibrates the chitin disc in much the same manner as an electrical vibrator. FIG. 5. The thin, paper-like wall of the abdomen, cut away, reveals a pair of enormous columnar muscles having a common origin ventrally and inserting into discs laterally and somewhat dorsally. (*Photographs 3, 4, and 5 by Richard L. Cassell.*)

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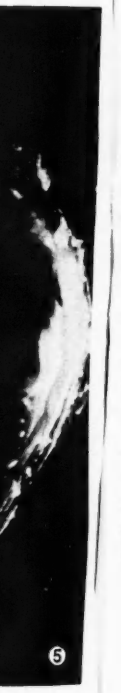

He sings by rapidly vibrating a pair of membranes or tymbals situated on the abdominal segments of his body. These are pulled inwards by special muscles and regain their former shape by means of their natural elasticity. The mechanism is the same as when a rounded tin lid is pressed by the finger, only to reassume its former shape accompanied by a sharp click. In some species each movement of the membrane produces a sound. The curvature of the tymbals can be increased by the contraction of accessory muscles. This increases the volume of the sound and at the same time lowers its frequency. The note can be heard to change if a cicada be gently squeezed between the fingers whilst in the middle of his carolling.

In some species the song is quite deafening and becomes exceedingly monotonous. From afar it may sound like a cross between a distant threshing-machine and a frog-pond. In others, it has been likened to a handbell, a steel knife on a grindstone, the rattle of a rattlesnake, or even a steam-engine whistle. Female cicadas do not possess sound-producing organs, and the Greek satirical poet Xenarchus, evidently a married man, wrote, "Happy the cicadas' lives, for they all have voiceless wives"—a couplet which has since been quoted almost *ad nauseam*!

Cicadas not infrequently sing in unison and are able to keep time with marvellous regularity. Although the songs of each species are remarkably constant so that they can be used for purposes of identification, yet the organs by which they are produced are superficially much alike. Indeed, cicada music depends more upon the player than the instrument. The fact that there is some variation in sound between individuals of the same species suggests that the song may, in part, be learned, as it is in grasshoppers, by the process of imprinting. This is a special type of learning, found mostly in birds and insects, which takes place very quickly and is almost irreversible. An example is afforded by the pathetic case of a grasshopper who, at an early age, was taught the wrong song. Thereafter females of his own species ignored his supplications, so he was doomed to a life of continual frustration!

Cicadas can hear each other singing by means of special auditory or tympanal organs. These consist of a thin cuticular drum exposed on one side to the external air, while to the inner surface is connected a group of special sense-organs or "scolopidia". The function of song is to assemble a local population of cicadas into a small group, but it is not yet certain whether it is the main stimulus employed in courtship.

Female cicadas are armed with powerful ovipositors with the aid of which a cell is excavated from the solid wood of twigs and the stems of young trees. Some species seem to prefer softer plant tissues such as the stems of rushes and grasses, while *Cicadetta montana* in England has been known to oviposit in bracken. When they hatch, the young cicada nymphs fall to the ground and burrow into the earth. Here they dig subterranean chambers in which they live, sucking the juices from roots, until just before their final moult. Emergence takes place during the hottest days of the summer. The insects tend to climb up the trunks of trees, or cling to any available vertical support while the final moult is taking place. As the nymphal skins split, the adults emerge in thousands and soon the air resounds with the cries of the males.

One of the most romantic of insect life histories is that of the periodical cicada, *Magicicada septemdecim*, of the United States, which appears in great numbers after long intervals of time. Its periodical appearance is due to the fact that in southern latitudes the nymphs require thirteen years to develop, while the northern race takes no less than seventeen! In most species, however, the nymphal stage is of shorter duration.

It was long believed that adult cicadas ate nothing but dew and possibly certain species may not feed in the adult stage. The Mediterranean *Cicada orni*, however, feeds readily on the sap of ash-, olive- and pine-trees, while the "rain" from the so-called "rain trees" of South Africa, Mexico, and Australia is caused by the micturition of countless insects feeding amongst the branches. Nevertheless, cicadas are not of great economic importance, as they cause comparatively little harm to their food plants.

The arrival of the adult cicadas is the signal for the advent of hosts of enemies which prey upon them. These include squirrels, pigs, and many kinds of birds. Even sparrows, and other species which normally feed on grain, cannot resist a meal of a plump cicada. Nor do humans refrain from eating them in season. The Greeks, who kept cicadas in small cages made of rushes for the pleasure of hearing them sing, had a sufficiently practical nature to enjoy eating them, too. Even today, cicadas form an article of diet among the peoples of China, Malaya, Siam, Burma, and the aborigines of Australia.

According to Aristotle, cicadas are at their best before the skin bursts for the final moult. They should be killed by being submerged in water, then fried in oil with a pinch of salt and a little onion. This dish was sampled by J. H. Fabre, who said that it tasted more like shrimps than grasshoppers. The consistency of the insects was so thin, however, and they so much resembled parchment to chew, that he resolved not to try any other of the recipes recommended by Aristotle! An alternative method of cooking cicadas is to stew them. They are not themselves palatable then, since they become reduced to bits of flabby skin, but the broth is said to have a not unpleasant flavour, although it lacks substance.

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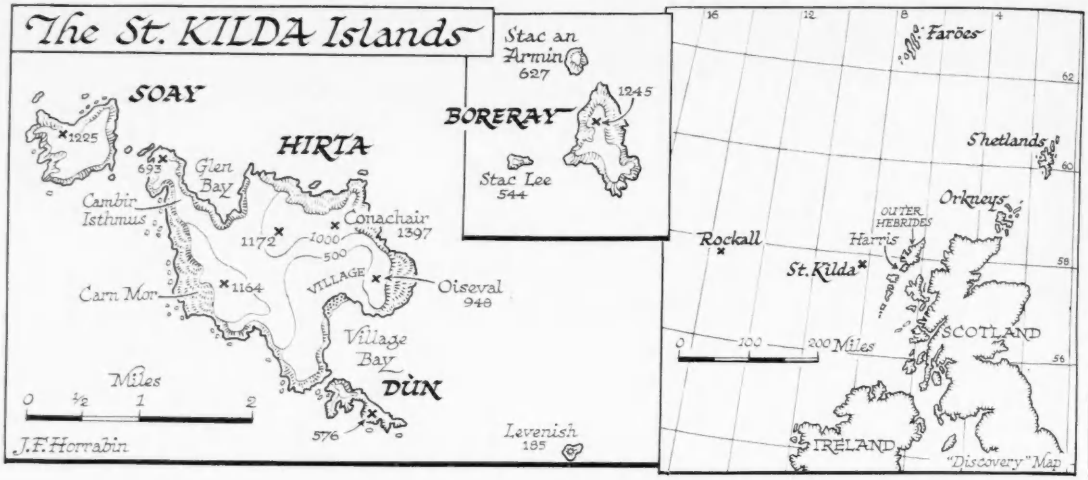

ANIMALS AND HUMANS AT ST KILDA

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There is no record of Darwin ever having visited St Kilda. Had he done so this peculiar little group of islands might well have featured in his classical writings. In his deliberations on the global distribution of organisms, the diverse fauna and flora of archipelagos fascinated Darwin. The peculiarities possessed by the birds of the Galapagos Islands were given prominence by him, and have subsequently been placed by others at the meeting place of two major branches of biological science: genetics and ecology. The plants and animals of Ireland, the Hebrides, Orkney, Shetland, and Scilly have long been regarded by British biologists as a rich field of inquiry. All possess small peculiarities which distinguish them from forms and associations prevalent in mainland Britain and continental Europe. With his great perspicacity and from his highly informed viewpoint, there is little doubt that Darwin would have recognised in the St Kildas the unique qualities with which they are now known to be endowed, and might have used them in the same context as the Galapagos, the Madeiras, and the Azores.

GEOGRAPHICAL CHARACTERISTICS

The St Kilda isles lie on the edge of the continental shelf 50 miles west of the Isle of Harris, Outer Hebrides, and are on the utmost rim of western Europe. There are four of them and several stacs. Hirta, the main island and the only one which has in historical times been settled by man, extends to 1575 acres. The three other islands, Soay, Boreray, and Dùn have areas of 244, 190, and 79 acres respectively. There are two clusters. Hirta, Soay, and Dùn form one, in which the islands are separated from each other by sea-filled chasms a few hundred yards broad, while Boreray and the two gigantic stacs, Stac an Armin and Stac Lee, form another some 4½ miles to the north-east of the first. Only on the clearest days can they be seen from Harris, and then usually for a short time. The orographic cloud-canopy is seldom absent from the hill crests, and transient banks of sea-fog block the view. Although bearing a natural affinity to the Outer Hebrides, the character of St Kilda approaches that of an oceanic island more closely than does any other of the British Isles.

St Kilda rises abruptly from the ocean floor at a depth of about 50 fathoms, and rises to a height of about 1400 feet above sea-level. The island group is the fragmentary remains of a Tertiary volcano of similar age and structure to those of the Cuillin Hills of Skye, Rhum, Ardnamurchan, and Mull, and appears to have escaped the Quaternary ice-sheet. It is composed of a round block of granophyre (granite) about two miles in diameter embedded in a context of olivine eucrite (gabbro), with an intervening band of breccia, and a complex of sills and dykes. The only part of the central granite block that remains above sea-level is the eastern hills of Hirta: Conachair (1397 feet) and Oiseval (948 feet). The band of breccia running between the two major formations divides Hirta, and can be seen outcropping on the Village Bay shore between the beach and Dùn. The remainder of the archipelago is composed of gabbro, including the isles of Soay and Boreray.

The impact of the ocean upon these rocks has had the most startling results. St Kilda possesses the three highest sea-cliffs in the British Isles. Conachair on the northern wall of Hirta falls about 1300 feet to the sea, and the walls of Soay and Boreray about 1200 feet in both cases. Stac an Armin (627 feet) and Stac Lee (544 feet) are the loftiest sea-stacs in Britain. In the

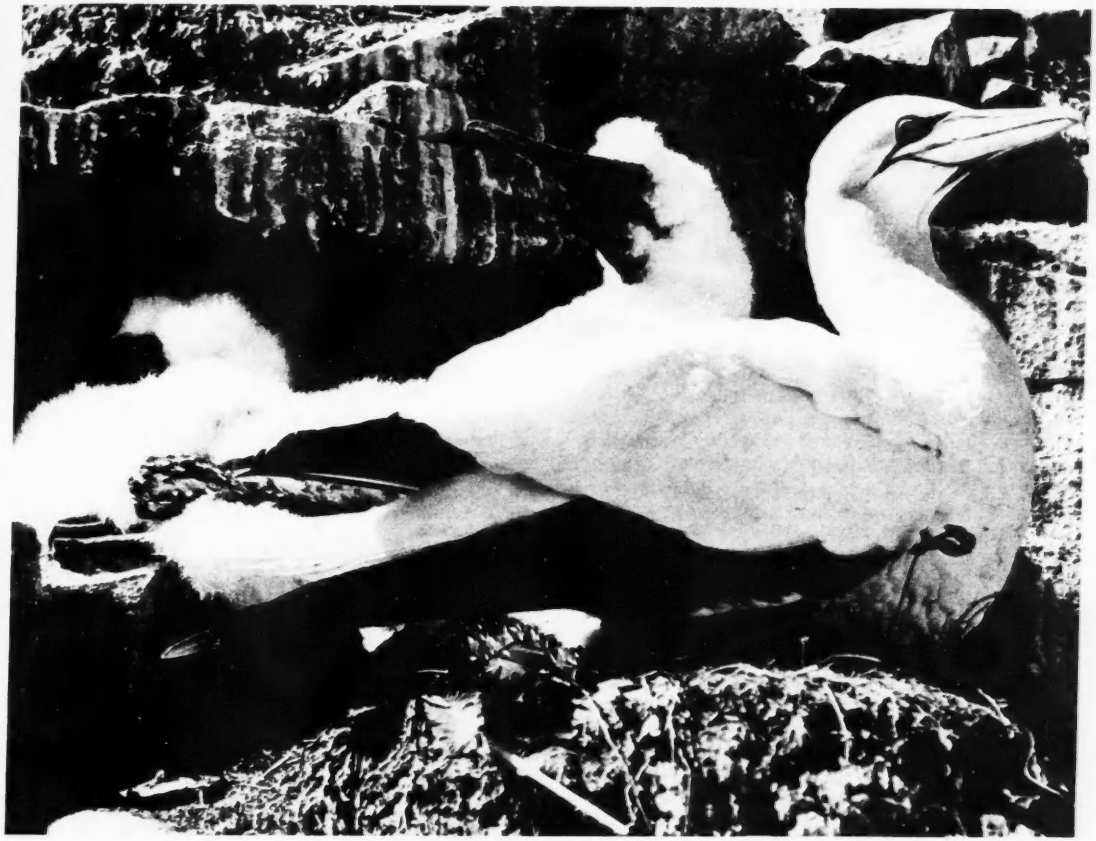

FIG. 1. A gannet with chick on the nesting ledge at St Kilda. Probably over 20,000 pairs nest there annually, each hatching a single offspring. While nesting, parent birds range into the Minches in search of food.

FIG. 2. Members of a small flock of Soay sheep which were taken from Soay, St Kilda, and have been kept as pure breeding strain at the Royal (Dick) School of Veterinary Studies, Edinburgh. In the foreground are the heads of a ram (*left*) and a ewe. Note the throat tuft of the ram and the non-everted curve of the horns which are characters of the wild mouflon.

chasm between Hirta and Soay there are two spectacular stacs, both over 200 feet high. The great stacs, nestling as they do under the soaring tower of Boreray, whitened and plumed with a cloud of gannets, are stunning to the human mind. The prospects from the edge of the Conachair abyss, and from the western prong of the forked crest of Boreray are equally overpowering. The scenery of St Kilda, its green glens and terraces, its purple hills, its skyline of paps and serrated ridges, its fang-shaped stacs, the sheer might of its bird-bespeckled cliffs, the yawning portals of its great seal-haunted caves, and its over-all upthrust from the blue plane of the ocean, is the finest in its own class.

POPULATION

Who were the first settlers of St Kilda? No one has ever discovered. There is evidence of generations of building in Hirta which retrace several centuries, and a primitive breed of sheep closely related to the aboriginal races are thought to have been introduced by the Norsemen about a millennium ago. When Martin visited the islands in 1697 there were 180 inhabitants. A century later the population had fallen to 87, due mainly to a smallpox epidemic, but in 1822 there is a record of 108. The immigration of 35 people from St Kilda to Australia in 1855 reduced the population to 78 in 1862, and the community never recovered from this blow, though numbers did not drop below 70 until 1921. Thereafter the decline was extremely rapid due to the departure of the younger people to a more promising life elsewhere, and a corresponding fall in morale in the beleaguered little community. In 1930 the entire population of 43 souls with their live-stock was evacuated at its own request to the mainland.

Before 1860 the houses were low thatched cottages probably similar to the "black" houses of the Outer Hebrides, consisting of one large chamber with the fire in the middle of the earthen floor. Earlier, however, the dwellings seemed to be double-chambered, one room for live-stock (in winter), and the other for the people. By 1870, sixteen houses of modern design were built by the laird, and probably about that time the factor's house and the church buildings together with the schoolroom were also built. At the opening of this century a concrete jetty was constructed and equipped with a ramp and winch for hauling boats clear of the sea.

It is doubtful whether the community on St Kilda was ever self-supporting. In historical times the economy of the islands was managed by the lairds, who provided for most of the needs in return for produce. Crofting agriculture prevailed, but the principal natural resource was not from the soil but from the sea. Though a small fishery, mainly of ling, was prosecuted and the fish salted for export, the wealth of the St Kildan was to be found on his section of cliff. Sea-fowl, principally puffins, fulmars, and gannets, presented him with the greater part of his protein and fat diet, with feathers to line his bed, and with a means of income. Rents were paid in kind: feathers, wool, oil, and salted fish. Spinning and weaving was carried on, and tweed provided a source of income.

FAUNA

In the past 250 years a large number of people who visited St Kilda have left accounts of their experiences. Not all visitors were naturalists, but all found a compelling interest in the sea-fowl, mainly because those were inseparable from an interest in the St Kildan himself. James Fisher, in his fine synopsis of the history of St Kilda in the *New Naturalist*, 1948, mentions principally those responsible for the description of the important members of the fauna: the house-mouse, the field-mouse, the wren, the great auk, and the Leach's petrel. The documentation of the animal and plant communities at St Kilda parallels the growth of interest in natural history in Britain during and after the life of Darwin, and in more recent times has entered fully into the province of ecology.

In 1930 a group of ecologists from Oxford and Cambridge recognised the evacuation of the human community as a signal event in the natural history of the islands, and in a survey in 1931 laid the foundations of a study which was to extend indefinitely into the future: the re-establishment of natural communities in place of cultivation. Of special interest was the release of the luxuriant maritime vegetation of Hirta from sheep grazing. This experiment was destroyed in 1932, however, when the laird, the late Marquis of Bute, introduced a balanced flock of 107 Soay sheep, from the Isle of Soay, but a new study was thus instituted: the growth of a ruminant population in a closed habitat. The future of the house-mouse in the absence of man aroused great interest, and also the gradual colonisation of the deserted village with birds normally shy of man, such as the snipe, oyster-catcher, and eider duck. Changes were also expected in the vegetation of the derelict croftland, and the unmolested concourses of sea-fowl.

The Soays measure usually between 20 and 25 inches at the withers when fully grown. Cossar-Ewart (1913), who made a wide study of aboriginal sheep, stated that in gait, carriage, and wild instincts the Soay ram is wonderfully suggestive of the Mouflon of Sardinia. Some characteristics, such as the horns on some ewes and some rams with everted horn tips, are suggestive of Urial ancestry. He thought that the Soay was a variety of Mouflon originally adapted for a moorland life. The fleece of the Soay is very fine, and may be dark or light brown.

There are now two populations of Soays at St Kilda. The original flock still survives on the Isle of Soay, and the 1932 foundation flock on Hirta, which probably possesses a trace of Blackface character from a few stragglers left by the St Kildans, has greatly increased. In 1952, after twenty years' freedom from man, numbers rose from 107 to over 1100. A count made in 1955 showed a decrease to 710, and in 1956, 750 were counted. The increase in the sheep population was not paralleled by an increase in the number of predatory birds such as the crows and the greater black-backed gull. At high density there were obvious signs of overgrazing in most parts of the island, and it is probable that a poor winter food supply caused the decline. In

1955 a large number of carcasses of very young lambs were found, while in 1956 comparatively few lambs were at foot with ewes. Starvation probably struck the old animals at the peak of the winter, and the lambs in spring due to lack of milk. The flock of feral Blackface sheep on Boreray, which was left by the St Kildans and has been untouched since 1939, numbered 340 in 1951, and 370 in 1956. These sheep appeared to be in good condition in 1956 with the pastures luxuriant in June, but, as with the Hirta Soays, there were few lambs at foot with the ewes.

One of the first recorded changes in the animal populations after the evacuation was the extinction of the indigenous St Kilda house-mouse. This subspecies is thought to have existed for two years only, in the absence of man. In the case of the indigenous St Kilda field-mouse, however, selection acted in the opposite direction, and the population increased in the absence of man with his domesticated cats and dogs. Interspecific strife may have contributed to the extinction of the house-mouse, since on Lunga of Treshnish, which has been uninhabited for nearly a century and where field-mice apparently do not exist, there are house-mice now occupying the habitat of the field-mouse. Had the more robust field-mouse been absent from Hirta the house-mouse might well have been able to adapt itself to the new situation. The extinction of the house-mouse may have been averted had it been introduced at the evacuation to Boreray, where there are no field-mice.

In 1955 as many field-mice were trapped in 100 trap-nights as were trapped in 650 trap-nights in 1931. Taking into account that trap-efficiency has improved in the interval, the population of this subspecies is much denser now than when the village was tenanted. Before 1930 it was entirely nocturnal, now it is also diurnal in habit. When fully grown the St Kilda field-mouse weights 10 to 15 grams heavier than the mainland form.

Apart from plumage and size differences, the St Kilda wren is also thought to possess a different sex-bond from the mainland wren. Studies in breeding behaviour of birds are more suited to the back garden than to a place like St Kilda, which can only be reached for short periods and at great expense. Birds should be marked and watched closely and continuously. So far this has not been done at St Kilda, but in 1955 and 1956 information was obtained which shows that the St Kilda wren in the village area may be polygamous, but polygamy appears to be less highly developed than in the mainland wren. This was done by plotting the singing perches of cocks in the dawn chorus (when all present may be heard singing at the same time), the different day-singing perches, and the sites of different broods of fledged young. By July 22, 1956, when observers departed, evidence of five or six cocks were obtained and eight broods of fledged young. By the end of July there would probably have been more broods. Broods fledged in August may possibly be second ones.

The first Leach's petrel to be described was taken from the Isle of Dùn in 1818, and though a succession of well-known ornithologists visited St Kilda before 1955, none had ever been able to find the nesting sites of this species on Hirta. In 1955 a colony probably over 100 pairs strong was discovered beside a colony of Manx shearwaters on the Carn Mòr, a boulder-strewn terrace on the western cliffs. In 1956 further smaller colonies of Leach's petrels were discovered among the talus on fairly inaccessible terrace on the eastern shoulder of Conachair, and on talus slopes on either side of the Cambir isthmus. An undescribed colony of storm-petrels was also found on the Carn Mòr beside the Leach's and the shearwaters. In 1956 Dùn was visited in darkness, when the petrels are active over the nesting site, and for the first time the Leach's colony was described. Probably about ten times as many pairs nest there as on the Carn Mòr, forming one of the largest colonies in Britain. In 1956, four hitherto unrecorded colonies of Manx shearwaters were also found.

The gannet colony on Boreray and on the two giant stacs is the largest of its kind in the world. A census of 1939 showed that about 17,000 pairs were breeding, in 1949 the strength of the colony appeared to have increased, and in 1956 it probably exceeded 20,000 pairs. Another full-scale census is scheduled for 1959, and until then an accurate estimate will probably not be obtained. Annual counts of gannets on Ailsa Craig have shown, however, that a nesting colony of gannets may almost double its strength in half a decade, and again be on the decrease. Counts at intervals of ten years may thus fail to detect comparatively large-scale fluctuations, and may be of limited value.

THE ISLAND'S FUTURE

In the past twenty-five years, while in the possession of the late Marquis of Bute, the islands have been maintained as a strict sanctuary, permits to visit were required and a ban on the removal of any specimens whatever their nature was imposed. In 1949 the Scottish Wild-Life Conservation Committee, in a report, said of St Kilda: "It is essential that this unique island group should be maintained as a reserve for all time." The Air Ministry have recently announced that the islands are included in the plan for the Hebridean guided-missile range as a radar surveillance station, and by the time this goes to press the sanctuary will have been violated by a few hundred contractor's men. Following upon this announcement, the National Trust for Scotland have decided to accept St Kilda by request of the late Marquis of Bute, and have leased the main island to the Nature Conservancy, who, in turn, will sub-let small areas to the Air Ministry for the radar installations. The Conservancy intend to appoint a warden to safeguard the interests of the sanctuary, and of the National Trust.

The animal communities in the village area of Hirta will be greatly disturbed during the contractor's operations, and it is clear from the proposals that by far the greater part of the walled village will disappear. The populations of wrens and field-mice will be particularly affected, but in the absence of guns the sheep flock and the great colonies of sea-fowl should remain unaffected. Nothing can be done with regard to conservation of the wren community in the village, but this is a small

FIG. 3. Stac an Armin (627 feet) viewed from the summit of Boreray (1250 feet). This is the highest sea-stac in Britain and is the nesting site of several thousand gannets and fulmars.

fraction of the entire wren population of the archipelago, and there is little chance of extinction. Something, however, can be done to save the mice, which might be transplanted for the time of the operations. The greatest danger to all departments of the indigenous fauna is the possibility of introductions, particularly of small carnivores and the brown rat, and the duty of the warden will be to ensure that all imports are free from such animals. No cats or dogs should be allowed on the island, and all traps should be in the hands of the warden.

St Kilda has been "Nature's last half-acre" in Britain for a quarter of a century; not only has it been uninhabited, but it has been completely unused by man. It seems a great pity that the sway of Nature in her only remaining stronghold in Britain should be thus disturbed. The fact that the Nature Conservancy and the National Trust will be with the Air Ministry at St Kilda, however, means that there is still hope for the future of the islands as a sanctuary. Co-operation between those interests will mean that all is not lost, and that a wider section of the nation will become aware of this new and wonderful acquisition. It is hoped that the Air Ministry crews will be able to safeguard and share in the exploration of the sanctuary, and that more people will be able to reach St Kilda to enjoy its superb endowment of wild life and overpowering grandeur.

On March 7, 1957, Lord Wemyss, Chairman of the National Trust for Scotland, presided at a Press conference on St Kilda. Spokesmen from Air Ministry, the Nature Conservancy, and the School of Scottish Studies announced plans for the future of the islands. The Air Ministry intend to make the roads connecting the various installations on Hirta during the summer of 1957, and to establish the technical and domestic buildings in 1958. About 300 men will be employed in the road-making—more people than probably have ever been on the island at the one time—and some of the old buildings will be renovated to accommodate them. The National Trust intend to preserve most of the ruined village intact, and to ensure that the construction work will cause a minimum of disturbance. Nature Conservancy and the National Trust will be represented on St Kilda during the operations in 1957 by Mr Kenneth Williamson, until recently the Director of the Fair Isle Bird Observatory, and by the author. It is hoped, however, to appoint a warden in the near future, who will be resident on the island for most of the year. The School of Scottish Studies announced plans for the exploration of the village ruins to detect the remains of earlier settlements. When the radar station becomes operational there will be about thirty airmen stationed at St Kilda, and it is hoped at some time to set up a bird observatory and a centre for biological studies.

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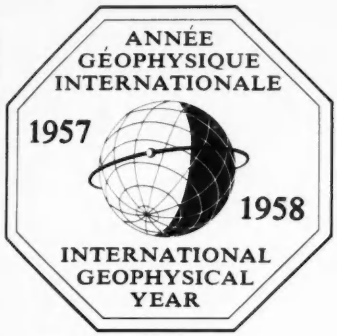
THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome



Fourth Antarctic Conference in Paris

It was thought last August when the third Antarctic conference took place in Paris and received the reports of the expeditions' advance parties that a further conference before IGY started would be unnecessary. Several fresh developments in Antarctic affairs has made this hope vain. A fourth conference was held in Paris between June 13 and 15. It was attended by all twelve countries participating in current Antarctic and sub-Antarctic ventures, except Norway; the South African delegation only attended the second part.

The operation of the Antarctic Weather Central at Little America V received much attention. Dr Harry Wexler, the American meteorologist, gave a report on the position. Difficulties have been encountered in its operation; these have centred on the obstacles to effective radio communication in this area generally and across the auroral zone in particular; AWC is situated just within the zone itself. Weather broadcasts from Little America are, it appears, not reaching everybody concerned. They are, however, being received clearly at Mirny, and the Russian delegation therefore offered to provide an instantaneous relay to points north from there. It is the Southern Hemisphere weather network that is chiefly suffering from delay or inability to receive the AWC synopses. From Mirny distribution to the respective areas could proceed through South African, Australian, New Zealand, and Argentine weather centres.

The visits and exchange of weather personnel between Antarctic stations, and particularly the offer from the Americans to receive a few foreign meteorologists at Little America, has proved so popular that there is to be an expansion of the scheme during the forthcoming year—if accommodation can be arranged. The Russians, for example, who already have an observer at Little America, were keen to send others.

The question of an extension of the IGY for the Antarctic sector which was raised earlier this year was formally discussed. However, only two or three of the countries with expeditions in the field saw their way clear to approving such an extension. Some countries, including the Australians, the British, and the Chileans, opposed such an extension outright. Others, such as the French, the New Zealanders, and the Argentines, expressed approval but foresaw difficulties, financial in particular. Only the Americans, Russians, and the Belgians were unequivocally for the scheme.

The conference decided to accept the suggestion of the New Zealanders for the holding of an Antarctic Symposium in New Zealand in March 1958, when the various expeditions will be pulling out after their IGY vigil and several of them (for instance, the large American party and the Trans-Antarctic group) will actually be in New Zealand in any case.

The Argentine delegation issued an invitation to an Antarctic Symposium to be held in their country in November 1959 and to include a fifteen-day tour of Argentine's Antarctic "territory". This suggestion was met with some reserve.

Two unusual requests from scientists were put before the meeting. One was for soil samples from Antarctica from a scientist at Göttingen. An Italian vulcanologist wanted information about the two famous volcanoes on Ross Island: Mt Erebus and Mt Terror.

Antarctic Perspective—Continued

France: The great achievement of the last season's French expedition in Terre Adélie was their successful establishment of Charcot, the inland or Plateau station—near the Magnetic Pole, at 69°22′ S, 139°2′ W; 2400 metres high. The weather here is the worst in the world. Mawson discovered this during his Commonwealth expedition of 1912–14, and commemorated the fact in the name he gave his book, "The Home of the Blizzard".

During four months of activity on the Plateau, mostly between Dumont D'Urville (the coastal station) and the Magnetic Pole area, 275 miles apart, there were only five days without high wind. This gave only twenty effective working days out of 120 in the field. Blizzards up to 160 m.p.h. were met; apart from these the expedition's greatest obstacle was "snow-lumps". These, often a yard in diameter, were thrown up by the blizzards and made progress for the tractors towing loaded sledges extremely difficult. (Various factors had made air support for the establishment of this station quite impracticable.)

On October 1, members of the 1955–6 party set off on the first base-establishing trek inland, by *Snocat* and *Weasel*, with a load of stores. By Christmas, four round trips had been made to the station site by this team, which consisted of seven men, two *Snocats*, two *Weasels*, and a number of heavy sledges. Seventeen tons of stores and equipment had reached Charcot.

The base-establishing party was led by Robert Guillard, a tractor-sledging expert with much experience of mechanised travelling during spells in Greenland with Expéditions Polaires Françaises. In December a blizzard descended on the sledging party while it was crossing a badly crevassed area, and halted it for three weeks. Building operations began on Christmas Day 1956. On January 1 three of the party brought down two *Snocats* from the Plateau station in readiness for transporting the three-man wintering party which had just arrived at Dumont D'Urville from France.

On October 7 *Norsel* left Le Havre with this year's main party under Dr M. B. Imbert who was the leader in the field for the substance of last year also. The expedition ship had an ice-free passage reaching Pointe Géologie on December 23; 350 tons of stores were landed in good weather—an operation to which the expedition's Bell 47G2 helicopter contributed, flying 105 hours in a month between offshore ship and island-choked coast. The helicopter also successfully flew 15 tons of petrol inland as a cache for the motor vehicles journeying along the route to Charcot. At this staging point, de Gerlache, the Belgian leader-designate, and Mr G. Rouillon, one of the senior members of the French 1957 party, spent some time early in the new year.

As soon as unloading to the shore was complete, *Norsel* left to carry out a hydrographic survey along the coast. Ashore at the Dumont D'Urville station the buildings were enlarged and the auroral radio-echo apparatus devised by Jodrell Bank and under the direction of Kenneth Bullough from there, working with a French technician, was satisfactorily installed. This apparatus is substantially identical with that established by Brennan at Halley Bay and the other in operation at Jodrell Bank. The information to be gained from continuous simultaneous records from these three widely distributed points should be of the greatest interest. They form the first *network* of auroral radio-telescopes in existence.

On January 13, two *Snocats* and two

Weasels and a party of four men conducted the Charcot wintering party of three (just arrived in *Norsel*) to the inland station. The establishing party left Charcot in two *Weasels* on January 19, leaving the wintering party under Jacques Dubois, a meteorologist, in sole occupation. The station was finally declared established on January 30 (presumably indicating that all building and installation works were complete).

There has been a regular meteorological exchange by radio between the French expedition and several others (including that of the Russians and Australians) for some little time past. Contact had not been achieved with Antarctic Weather Central at Little America V as of the end of March, however.

Norsel left with the previous season's wintering party aboard in March. At Dumont D'Urville at the beginning of the IGY there were twenty men, though both this station and Charcot will have a greater number operating from them during the summer season.

More Rocket News

Australia: More details have now been gleaned of the recently announced Australian rockoon research programme to be operated from Woomera during the IGY in addition to Great Britain's *Skylark* project.

In the rockoon a very large polythene balloon will carry a 600-lb. payload to 60,000 feet. The rocket component is to be an 18-foot-long, 10-inch diameter solid propellant rocket, designed to develop thrust producing 2000 m.p.h. as it leaves the launching ramp dangling from the balloon. This will carry the remaining payload of instruments up to 60 miles high before burnout. Measurements will be telemetered to ground during the flight.

The balloon component is to be of the expandable polythene "Visqueen" type made by ICI, with walls only 1/60-inch thick. Bristol University workshops, which have had much experience of balloon-making for the university's cosmic ray work (DISCOVERY, March 1957, p. 121), will make up this material into balloons 100 feet long before inflation. The balloon will be inflated at Woomera with 12,000 cubic feet of hydrogen. It will be 80 feet high by 25 feet in diameter at launching. At balloon ceiling (60,000 feet or about 11 miles high) the hydrogen expands to 100,000 cubic feet, producing a nearly spherical shape, 60 feet long by 50 feet diameter. To combat the balloon's increased fragility at this height, which is partly due to the cold (perhaps −70° F), the polythene is dyed salmon pink to absorb solar radiation.

Japan: Besides the *Kappa* rocket programme already announced (DISCOVERY, January 1957, p. 34) the Japanese are also planning to release a species of small rockoon, the *Sigma*, for IGY researches. Final tests took place in April and May over the Pacific.

Alexei Pokrovsky, a Russian geophysical research worker, arriving with the three dogs, Malyshka, Linda, and Kozyavka, at a press conference in Moscow which was held to open the IGY. The experiments carried out with these three dogs, and their rocket flights to a height of 85 km., were fully described in DISCOVERY 1957, vol. 18, p. 180.

Two successful test series of *Sigma* launchings were made last year, the first using dummy rockets sent off from a ship in September, and the second to check the operation of a pressure-sensitive ignition system and the effect of great cold at height on the solid propellant, in November.

The rocket component of *Sigma* weighs 22 lb., and is expected to reach an altitude of between 55 and 65 miles.

Twenty each of the *Kappa* and *Sigma* sounding rockets have been scheduled for firing during the IGY by the Japanese National Committee. The *Kappa* research programme (operating up to 80 miles with a 15 lb. payload) is to include observations of air pressure and temperature, upper air winds, solar radiation, cosmic rays, and ion density.

U.S.A.: The United States rocketeers are nearing completion of development of a solid propellant version of the *Aerobee*, which is expected to attain a height of 200 miles with a payload of 100 lb.—a very useful performance indeed. This rocket is called *Iris* and is much cheaper to produce than most of the other American sounding rockets. This puts it more within the range of research organisations without defence programme affiliations, such as university departments.

Bolivia's Record High Cosmic-ray Station

At the high-altitude research station at Chacaltaya, Bolivia, which stands at 17,000 feet, a cosmic-ray telescope has recently been installed and will be operating throughout the IGY period. This is the highest point at which continuous records of incoming cosmic rays has ever been kept. The telescope, which was built in the cosmic-ray laboratory at Imperial College, London, for Dr Armenteros, was obtained through a grant from UNESCO. The telescope consists of trays of Geiger counters aimed obliquely at the sky, and is designed to record incoming cosmic rays from three directions—east, west, and south. It is known that the earth's magnetic field operating high above the atmosphere deflects the primary cosmic rays so that particles of different energy come from particular directions. At tropical latitudes this process can be seen at work, but at sea-level the pattern is almost lost due to the absorption of the low-energy particles. Chacaltaya combines the advantages of great height with a very low latitude. It is almost on the Equator.

Cosmic Rays Over the Antipodes

A specially equipped aircraft of the RAAF made a preliminary flight over Victoria, Australia, in May, to measure incoming cosmic radiation at height above the earth's surface. The research is being conducted by Dr A. G. Fenton, Reader in Physics at the University of Tasmania and convener of the cosmic-ray section of the Australian IGY committee.

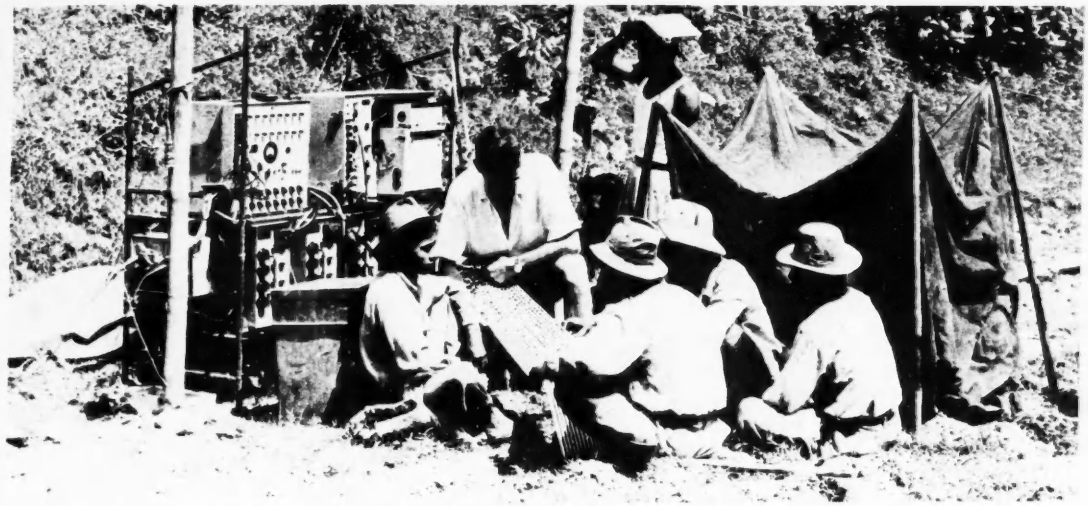
In a statement he linked the flight with others being made and to be made from the far north right down to the Antarctic. Already (see DISCOVERY, November 1956 and March 1957) cosmic-ray measurements associated with IGY activities have been conducted from aircraft, over the Equator by Simpson of Chicago and across the trans-polar air-route by Sandström of Uppsala. It appears that the Australian flight over Victoria is only one of a series to be carried out by Australian scientists.

Dr Fenton remarked that the Earth's magnetic field, particularly at great heights, is influenced by low-energy particles (or corpuscles) from the Sun; it may be possible to judge the extent and nature of this influence by measuring cosmic-ray density at height.

Canadian Ship to get Beyond 83° North?

Recently the magnificent Canadian naval icebreaker of 6500 tons, H.M.C.S. *Labrador*, entirely built in Canada, paid a visit to northern European ports. She was on view in Portsmouth dockyard for ten days.

Although *Labrador* was only commissioned in 1954, she already has an impressive list of records behind her and there is a plan to crown these this summer by voyaging nearer the North Pole than any ship has got before. At present the record is held by the Russian ship *Fedor Litke* which reached 83° 11′ N in 1955. (Curiously the *Fedor Litke* was launched from a British shipyard early in the 1900's as the *Earl Grey*.)



Typical of the many seismological stations working during the IGY is the one illustrated above, taken at Madura, eastern Java, Indonesia. At this station search for oil is carried out and the party is examining the records of the day's "shooting". (*A Shell photograph.*)

Labrador is fully equipped for a range of scientific work and on each of her summer voyages to Canada's far north—and she regularly visits the northerly part of Ellesmere Island—scientists make the fullest use of the opportunity to study conditions in these remote and inaccessible regions. Two years ago a cosmic-ray survey which has had important results was conducted from her. During the coming year she is to be put under full contribution for IGY studies.

In design, *Labrador* is essentially a *Wind*-class icebreaker (*Edisto*, *Northwind*, and *Eastwind* of the U.S. Navy that have been active in the past two seasons off Antarctica are *Wind*-class icebreakers), but she incorporates several important modifications on the U.S. naval version.

Runway Ironed Out of Giant Ice-Floe

United States Eighth Air Force engineers have been busy during the past two or three months preparing an airstrip to fly in and keep supplied the IGY station being set up in readiness for July 1, on "Fletcher Island". This, probably the largest detached piece of ice in the world, is drifting in the Arctic Ocean within 100 miles of the North Pole. The strip was ready for air traffic in May and the station was put in on May 22. Scientists and thousands of tons of gear were flown in from Alaska by large Air Force cargo planes.

A runway 5000 feet long was literally ironed out of the surface ice. The method used was to spread tarpaulins on the ice and blow hot air beneath them. The surface ice is temporarily melted, and while in this condition can be pressed through the tarpaulin; when the surface refreezes, it is smooth.

Fletcher Island, otherwise known as T-33, is some years old, but for a while could not be traced. It was rediscovered last year.

Ice-Caps, Shrinking and Stable

Thirteen thousand feet up in the Tien-Shan mountains, which connect Kirghizstan with the Chinese province of Sinkiang, in Central Asia, Soviet glaciologists have discovered that one of the largest remaining ice-caps in the world is shrinking rapidly. This ice-sheet is fed by fifty-nine glaciers, and the IGY station already established for their observation has found that some of them are as much as 1000 feet thick. Shrinkage in recent years appears, however, to have been considerable—evidence from some of the glaciers show a withdrawal of a mile in just the last few years. It is believed to be due to rising summer temperatures in these mountainous regions of Central Asia.

In a recent extensive glaciological survey of the Greenland ice-cap at roughly the 80° parallel, into the interior from Thule, American scientists concluded that the Greenland ice here, unlike that almost everywhere else in the world, is at least holding its own. Deposition appears to match melting and also "travel". The ice surface of the cap was found to be moving at a rate of half an inch a day. The general trend is out and down towards the sea, Greenland being a vast turtle-back of ice. Observations during this survey, which is to be extended as a part of the IGY in co-operation with the Danes, included met-work, and studies on humidity, radiation, heat, windspeed, ablation at the surface, under-surface streams, and glacial "travel".

Arctic Robot Weather Posts

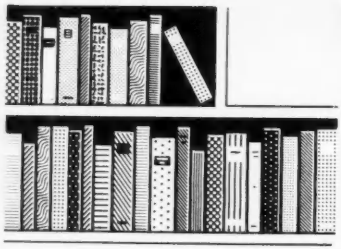
Fourteen more automatic radio-posts that record simple meteorological data and then transmit it at regular intervals to manned stations farther south are to be established by the Soviet Arctic Institute on ice-floes drifting near the North Pole this year. Apparatus of this type has been in operation previously and the results have proved worth while. The information these stations relay deals with air pressure and temperature and with wind conditions.

Computing Satellite Orbits

An IBM 704 computer at the Massachusetts Institute of Technology will be used to calculate the orbit of artificial Earth satellites. Data from visual observing stations in all parts of the world will be transmitted to the observatory in Cambridge, Massachusetts, where they will be made ready for use in the IBM 704 computer along with previously prepared data. The information will be fed into the IBM 704 at M.I.T., and it will take but a few seconds for the computer to produce an orbit. A man with a desk calculator would probably take eight hours to perform the same task.

The orbit will then be communicated to the Smithsonian Observatory's twelve-camera tracking-stations around the world. Using this "celestial time-table", the operators will know where and when to aim the cameras so as to photograph the satellite. These photos will allow for precise measuring of the satellite's position; they will also reveal information about the Earth and its upper atmosphere.

The Smithsonian Astrophysical Observatory will publish its predictions of the satellite's position over the Earth so that non-professional observers may know when and where to look for it with binoculars or small telescopes. The satellite will move 300 miles per minute.



THE BOOKSHELF

The Uniqueness of the Individual

By P. B. Medawar (*London, Methuen, 1957, 191 pp., 18s. net*)

The breadth of Prof. Medawar's knowledge, and the elegance and charm with which he can express it, will already be known to those who have seen his recent appearances on television. These characteristics survive very well even in the colder medium of the printed word. He has brought together eight essays, written during the last ten years, the majority of them of quite recent date. They range over a variety of biological topics, but are unified by a common concern with that broad area in which growth and development come together with heredity and evolution. This is an aspect of biology whose importance is becoming ever more widely realised. Great advances have been made in it recently, and to these Medawar has himself contributed much, both by his experimental work, the beauty of which has, unfortunately, no chance to emerge in a short book of essays of this kind, and by the clarity of his thinking. The latter quality we are given many opportunities of enjoying. Medawar has the enviable ability not only to think with precision but to express his thoughts with wit. Opening the book at random I find: ". . . whatever form evolution may take, or whatever may bring it about, contributions to evolutionary change are paid, if they are paid at all, in one currency alone: offspring". Which is, of course, one of the basic points of the modern theory of natural selection, and who could have put it better?

Why should not men be at least potentially immortal, and retain their full vigour until some disaster or disease carried them off? Medawar's answer is of course not simple; but, very roughly speaking, he suggests that the main explanation may be found in the argument that, since unavoidable accidents will in any case result in there being fewer old people than young ones, it will not be very harmful to the race if they become somewhat enfeebled. It may be easier for natural selection to circumvent the harmful effects of certain mutant genes by favouring the postponement of their operation until late in life than to do away with them altogether. This is a plausible and important hypothesis; it might be strengthened by a further consideration which Medawar does not mention, namely, that some genes which have harmful effects in later life may at earlier stages be producing slighter effects which are actually useful and favoured by natural selection.

Two of the other essays are concerned mainly with matters which arise from Medawar's well-known experiments on skin grafting and wound healing, and another deals with patterns of growth, a subject to which many of his early researches were devoted. The reader may feel assured that the theoretical discussions of which the book mainly consists are based on a solid foundation of critically investigated facts. These essays represent popular biology at its best.

C. H. WADDINGTON

Concise Encyclopaedia of Atomic Energy

Edited by Frank Gaynor (*London, Peter Owen, 1957, 204 pp., 37s. 6d.*)

This encyclopaedia covers a wide field. There are entries for names (for example, Dirac and Millikan), for places (Harwell), for units (Gauss), for materials (monazite), for instruments (ammeter), for processes (diffusion), and much besides. German equivalents of many of the entries are given. There are also a number of tables and lists, of which the following are examples: a table of isotopes; an alphabetical list of elements; a list of radioactive tracers most widely used in medicine and biology; a list of U.S. reactors; a list of typical radiation survey meters. A reasonable standard of technical accuracy is maintained, and the entries are both concise and readable.

The most serious criticism of the encyclopaedia is that much of it is out of date. Although the U.K. edition came out this year, it was originally published in the U.S. and the preface is dated May 1950. The missing seven years covers a large part of the comparatively short history of atomic energy. A note inside the dust-cover claims that the encyclopaedia has been "constantly brought up to date and revised", but there is little evidence of this. The following short extract from the entry under "Reactor", gives some idea of what is missing:

"Great Britain has two major reactors at Harwell, known as Gleep and Bepo (*q.v.*). Canada's reactor is known as Zeep (*q.v.*). France has a reactor at Fort Chatillon, near Paris, reported to be an uncooled reactor, using uranium oxide as reactor fuel and heavy water as moderator. A reactor is reported to be built or have been built in Sweden, but further details are not yet known. Russia has claimed recently to have completed a reactor or reactors, but these reports have not yet been confirmed or verified."

There is thus no reference at all to the U.K. nuclear-power programme, and in fact the only mention of the Industrial Group of the U.K. Atomic Energy Authority appears to be under the heading "Nuclear Energy Plant", where it is stated that "Great Britain has a fine plant at Harwell and another is under construction at Sellafield, Cumberland, although according to recent reports the work on the Sellafield plant has been halted." Sir John Cockcroft is said to be Professor of Physics at Cambridge. Much of the information in the tables dates in the same way, and indeed some of them (for instance, the list of American reactors on p. 166) are acknowledged to be taken from an Atomic Energy Yearbook published in 1949.

In view of this obsolescence, it is difficult to see how this book can be of any value except as a general scientific dictionary. Nothing more than a year or two old is likely to be of use to an active worker in the atomic energy field.

R. M. FISHERDEN

The Changing Universe: The Story of the New Astronomy

By John Pfeiffer (*London, Victor Gollancz, 1956, 244 pp., 18s.*)

"The Changing Universe", by John Pfeiffer, is a very welcome addition to that sequence of books from various scientists of distinction, such as Sir James H. Jeans and Sir Arthur S. Eddington, which have given expositions of advanced physical theories in terms comprehensible to the layman. It has been a feature of these works to show how the changes in man's knowledge of the physical universe are also modifying the place of man in that universe and thus influencing men's views on religion and philosophy.

Not unnaturally, the presentation of new discoveries in astronomy has proved the most attractive field of science to the lay public;' perhaps because the results of modern science can then be compared most conveniently with the orthodox philosophies symbolised by the first chapter of Genesis.

Mr Pfeiffer's book certainly reveals in a dramatic manner how man's knowledge of the universe has undergone a sudden and spectacular increase by the application of modern radio and radar techniques to the study of astronomical phenomena. Mr Pfeiffer shows clearly how the new radio tools which World War II provided have been used to detect radio-frequency energy from the remotest parts of the universe and the ingenious manner in which these techniques have been used to supplement the well-established optical tools of the astronomer in order to reveal creative evolutionary forces at work in the universe which must have remained undiscovered but for these war-time advances in electronics.

The author has wisely decided to build his book around the presentation of the experimental results which have been obtained from radio-astronomical experiments, and so he has reduced

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This book provides practical information on these new plastics. It discusses the general chemistry of the resins as well as their applications in industry. It attempts to answer the questions which will occur to the industrial chemist, designer and engineer. Sufficient detail is given for the specialist, but the non-specialist will find the book clear and readable.

300 pages | *illustrated* | *60s* | *October*

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theorising to a minimum. This is an excellent thing in a book of this type, since the reader who will derive value from it must first grasp the facts of the new astronomy unobscured by hypotheses that may soon be discarded.

Having regard to the mental background of the probable reader of this type of popular exposition of science, I think Mr Pfeiffer has too readily assumed that it is necessary to compel his reader's attention by rather lurid forms of expression which are the stock-in-trade of the writer of science fiction. Mr Pfeiffer is dealing with facts established by experiment, and I would have thought his subject-matter to be so interesting and exciting that it should be unnecessary to add the trappings of the scientific novel. This reliance upon words often produces obscurity in presentation which could have been relieved greatly by the use of a few simple diagrams and suppression of some of the more emotional sentences.

Nevertheless, the book is extremely interesting and succeeds in presenting a new and highly technical branch of scientific research in a comprehensible yet vivid manner. The book is especially suitable for the general scientific worker and also for the ordinary man and woman who is aware of the exciting times in which we live and whose horizons are not limited to the ITA or BBC Light Programme. E. EASTWOOD

Schweizer Pioniere der Wirtschaft und Technik (in German)

1. Philipp Suchard, 1955, 56 pp.
2. J. J. Sulzer, Henri Nestlé, Rudolf Stehli, C. F. Bally, J. R. Geigy, 1955, 44 pp.
3. Johann Jakob Leu, 1955, 31 pp., 16 plates.
4. Alfred Escher, 1956, 64 pp.
5. Daniel JeanRichard, 1956, 68 pp.
6. Hans Caspar Escher, François-Louis Cailler, Salomon Volkart, Franz Joseph Bucher-Durrer, 1956, 88 pp.

Pionniers Suisses de l'Economie et de la Technique (in French)

1. Philippe Suchard, 1955, 56 pp.
2. Daniel JeanRichard, 1956, 64 pp.

(All published by the Verein für Wirtschaftshistorische Studien, Zürich. No price given. The two French books are translations of the corresponding German ones.)

"A people's most precious good is its outstanding citizens, whose achievements and example lead it to higher planes of development. To provide a living picture of such men is not only to give them their due gratitude; it also opens up a source of energy through which others may emulate them."

These words are translated from a passage, thought to be due to Gottfried Keller, in an appeal for a memorial to Alfred Escher; they appear on the cover of each of these attractive booklets, which are conceived in their spirit. The Society for the Study of Economic History was founded in 1950, with the aim of studying the origins of Switzerland's technical and economic success, to throw light on the way in which it may go on to even higher achievements. In this spirit they are producing a series of biographies of men who have made decisive contributions to Switzerland's development. The accounts, however, are anything but bald success stories; indeed, Suchard's life suggests that the chocolate business must have been fantastically profitable to pay for his many bold ventures that failed in the end.

Within the limits they have set themselves, these booklets are astonishingly good. In thirty or forty pages of text, each gives a brief sketch of its subject, of his personal background and the economic and technological climate in which he lived, and his contributions to the industry of his time. Most of them give a bibliography for further reading. Each has a good collection of plates, often of considerable beauty; some of JeanRichard's watch designs are of great aesthetic interest. The writing is racy, with some distinctly good touches. I doubt if even the most self-centred trade union today would approve of the ship's engineer on Lake Neuchâtel who, being the only one available, could insist on an excursion party's stay overnight at their port of call because he liked the place so much himself. Indeed, an ability to appreciate one of these biographies would be a useful item in a battery of tests for finding that all-round and cultured scientist whose absence is so often lamented nowadays; for it would involve some sense of the industrial background to technological developments, some insight into personal character, and considerable fluency in French or German. It would be worth trying one or two of the biographies on a Science Sixth Form which was expected to be able to get around in the appropriate language.

And yet . . . after reading several of these, I began to wonder just what public such a series will serve. The biographies are much too long for anything like a complete coverage of the pioneers of even so small a country as Switzerland to be possible. On the other hand, they are too short to give a deep insight into character, while many of the activities of these astonishingly energetic and many-sided characters can get little more than a reference and a few dates, sandwiched between the more readable and even anecdotal accounts of their major interests. I was left with a feeling of amazement at their drive, their successes, and their resilience after failure; but with little more insight than before into the factors, whether their upbringing, their intellectual climate, or the industrial or technological circumstances of their time, made them develop as they did. Perhaps it is too much to expect—though to gain such an insight is set out as the aim of the institute producing the series. It is to be hoped that longer and deeper studies will also be published (comparable to Maclaurin's "Invention and Innovation in the Radio Industry" or Schlaifer's "The Development of Aircraft Engines") that do give pointers to the factors shaping technological development.

T. E. EASTERFIELD

On the Beach

By Nevil Shute (*London, Heinemann, 1957, 312 pp., 15s.*)

Taking T. S. Eliot's famous

This is the way the world ends,
Not with a bang but a whimper

as his text, Shute produces a most readable, though grim, novel of how this could easily happen in 1963. During a series of wars, a total of over 4700 nuclear bombs had been dropped in the Northern Hemisphere, where all life had been completely wiped out. The story, not unnaturally therefore, is set in Australia, with the Commander of the only operational submarine left in the world, atomic-powered, of course, as the hero. Radioactive contamination is rapidly spreading from the Northern to the Southern Hemisphere, by wind and sea, and the calculations of CSIRO give the people of Melbourne a few more months to live. All continue their life as if their inevitable death were not accurately foreseen. Perhaps the number of drunkards in the streets of Melbourne increases somewhat, but otherwise business is as usual, sustained by electricity. There being no oil in the Southern Hemisphere, anything not electric ceased at the end of the war.

Like a Greek tragedy, the lives of the actors in the story move to their predictable and inevitable ends. Each stays true to his ideals and upbringing, fulfilling in his last tragic months the wishes of a lifetime, such as racing a Ferrari car, or merely buying the cherished garden seat. There is no final miracle to save the last remaining survivors, and there is almost no whimper, as the majority prefer to swallow their cyanide tablets—issued free by the Medical Services—when the diarrhœa and vomiting become intolerable. "On the Beach" is certainly the most crushing and heart-sickening story yet written about nuclear warfare. It is total propaganda for universal atomic disarmament and as such should be read by all.

And yet, when all is said and done, it we know enough today, or at any rate shall do by 1963, to build a concrete and radiation-proof Noah's ark, so as to provide survival conditions for a small number of people and the essential animals to start life again when the half-life period of cobalt is over. To throw away all, if perhaps we can secure for a few the chance to repopulate the earth, seems very wasteful. But perhaps Shute has reserved the tale of the survivors to a further novel, in which the scientists

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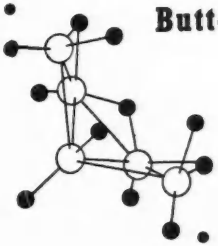

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and naval officers of New Zealand, surviving the Australians by a few days, will attempt to save millions of years of evolution. He might well quote Dylan Thomas as his text for the sequel:

Do not go gentle into that good night,
Rage, rage, against the dying of the light.

A. R. MICHAELIS

Bones for the Archaeologist

By I. W. Cornwall (*London, Phoenix House, 1956, 256 pp., 50s.*)

The purpose of this unusual book is to help in the identification and study of bones found at archaeological sites. The greater part of the book consists of a series of chapters on the parts of the mammalian skeleton. For example, the half-chapter on the shoulder girdle begins with a brief generalised description of this structure in eutherian mammals (and other mammalian groups are, after all, archaeologically unimportant outside Australia and perhaps the American continent) and then proceeds to describe the special features of the eutherian orders and in some cases of genera. This part of the book is followed by Chapter 12, on "Determination of Species from Bones". This starts with a key which should nearly always enable a beginner to discover whence in the skeleton a reasonably complete bone had come. The identification of the species or group from which the bone had come starts with the question, "What could it be, in point of size?" This consideration will evidently greatly limit the range of animals among which the search must be continued. Here one feels the need for a table setting out the size ranges of the principal bones of the archaeologically important animals; this could well replace the tables of classification, which probably do not much interest archaeologists, at the end of the book. After elimination by size, one compares the bones in question with the descriptive information given earlier, of course confining one's attention to those animals which the size elimination has left as possibles. The key mentioned above seems so successful that one wonders whether the information given in taxonomic order in the descriptive part could not similarly be made into a key. It should be said that the author appreciates and emphasises the necessity of studying identified bones in collections, and of comparing unknown specimens with such collections.

At the end of Chapter 12 is given a series of drawings of "unknown" bones, and the reader is invited to attempt their identification, using the information provided in this book, and then, in an appendix, to discover not only whether his identifications are right, but whether he has used the book correctly. Chapter 13 discusses fragmentary bones, and Chapter 14 deals with a number of matters of practical archaeological importance, such as excavation, measurement, and transport. Chapter 15 is on the "Estimation of Age, Sex and Stature from Bones", and the last chapter, again an eminently practical one, is on "Study and Interpretation".

The reviewer has noted a few points to which he takes exception. It is not true (p. 27) that "Charles Darwin . . . first propounded . . ." the Theory of Evolution. Few, if any, embryologists would now agree that autogeny, even "to some extent", recapitulates phylogeny (p. 28). It is not true that "all vertebrates have a more or less ossified internal skeleton" (for example, Cyclostomes and Elasmobranchs). It is incorrect to say, after referring to the extended pectoral fin-rays of some fishes, that "the next stage in limb development is seen in the Amphibia", for it was not from any teleostean fin that amphibian limbs evolved. These are not very important for the purposes of the book, but could perhaps be altered in future editions.

The real value of the book will be discovered by the archaeologist, but it is the reviewer's opinion that, if they use it as the author wishes it to be used, and combine with its use the study of museum material, they will find it very useful indeed. P. D. F. MURRAY

A Dictionary of Statistical Terms

Prepared for the International Statistical Institute with the assistance of UNESCO by Prof. M. G. Kendall and W. R. Buckland (*Edinburgh, Oliver and Boyd, 1957, 500 pp., 25s.*)

This enterprising work, sponsored by the International Statistical Institute, is evidently a labour of love. The absorption of scarce resources in such a formidable task may seem uneconomical. However, the value of a specialised dictionary in an entirely new field cannot be judged until it has been in use for several years; it may turn out to be more useful than could have been anticipated. That the need for it has been felt possibly implies a lack of really good general textbooks in statistics. The subject has, indeed, many branches and no one textbook: not even the monumental work by Prof. Kendall can be expected to meet all needs. The terminology employed by different writers depends on the branches in which they are interested and may not, therefore, be familiar to all their readers. A dictionary of terms which are currently employed is thus convenient; it can even help to expand the peripheries of one's knowledge; but it is not of course in any sense a substitute for a textbook. The authors have wisely chosen to steer a middle course, which they have done most skilfully, between giving full rigorous explanations and giving the gist in a quickly intelligible form. They have aimed at producing a useful working tool, rather than a comprehensive, conventional type of dictionary.

Some of the phrases coined by statisticians ("crypto-deterministic", "coefficient of alienation") are unhappy hybrids. Ordinary words are sometimes given strange meanings. A "random walk", harmless as it sounds, may lead into Queer Street. And it is surprising to find that "vanity effect" is a statistical term meaning—just the effect of vanity. The use of asterisks to distinguish the English translations of Italian terms seems unnecessary; many are perfectly good English words and those which are not English could have been omitted. The book includes valuable glossaries from French, German, Italian, and Spanish into English. Praise is due both to the authors and to the publishers for this excellently produced work of reference, the price of which is very moderate. J. L. NICHOLSON

The Specification and Management of Materials in Industry

By C. H. Starr (*London, Thames and Hudson, 1957, xii+294 pp., 21s.*)

In some industries the materials used or consumed in the manufacturing process receive inadequate attention both as regards choice and specification, yet their cost often constitutes a large proportion of the total outlay of the manufacturer.

Mr Starr deals with the need for and savings resulting from good "materials engineering" and advocates a central department in the firm so as to meet this need. His book is written primarily from the point of view of a manufacturer engaged on the quantity production of general precision light engineering work. For this type of manufacture the organisational structure he advocates is, no doubt, sound. There are, however, other industries where materials management looms so large as to constitute the principal problem of the production department and must therefore be dealt with by that department.

Mr Starr deals fully with purchase specifications for materials and components. He describes in some detail the organisation and conduct of a materials department suitable for the type of industry with which he is concerned. He also deals with the staffing and running of a laboratory to serve the needs of this department.

The compilation of purchasing and process specifications is described fairly fully as are also the use and utility of national standards and government specifications. Here it is regrettable that the author considers national standards to be useful mainly as a basis on and around which the firm can draw up its own specifications. Surely, in most instances the B.S. specifications, when they exist, should meet the requirements? Mr Starr rightly warns against the inclusion of unnecessarily exacting limits in specifications.

The book has two useful appendices dealing respectively with typical specifications and statistical methods.

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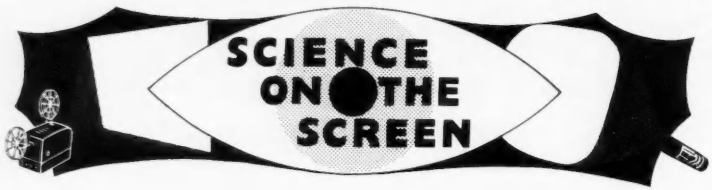


"The Bloodstream" on BBC Television

In a BBC television broadcast on June 12, the tercentenary of the death of William Harvey was commemorated in a 45-minute programme (Frontiers of Science) produced by James McCloy, well known for his series "Questions of Science", and for other science broadcasts. The subject was "The Bloodstream" and was happily introduced by the "Doctor" of the "Questions of Science" series. His three colleagues included a distinguished physician and a distinguished heart surgeon. It is irritating to see how strictly the silly taboo on names is firmly maintained by medical scientists. The television "Doctor" and the two distinguished guests, all outstanding scientists, approached their subjects in a grave academic spirit, and it is a childish anachronism that they should suffer anonymity while an equivalent non-medical professor of zoology discussing the same subject would be named.

The programme itself was a triumph and virtually without a blemish. Alfred Wurmser's delightful animated diagrams helped Harvey's advances over Galen to be clearly explained by the "Doctor" in a ten-minute introduction. There followed an exciting account of the marvel of the cardial catheter, from the physician guest, who described his own techniques and their uses with restraint yet authority, and illustrated his remarks with some admirable film sequences. This section concluded with a neat illustration of the method of use of the dye technique for studying bloodstream characteristics.

Then the surgeon, with models, and again with outstandingly good diagrams, illustrated the surgeon's methods of dealing with (*a*) obstructions in the heart and (*b*) leaks. Attention was focused on the restricted time factor in cardial surgery and the viewer was thus led logically to the reason for the modern artificial body-cooling technique for securing extra time. Again this section was admirably compressed into an allotted ten minutes and was indeed exciting in its very compactness.

The logical step to the by-passing of the ailing heart itself, with the fantastic mechanical device called the "heart-lung" machine, followed as a natural consequence of the emphasis on the time factor. With film sequences the heart-lung machine was shown in actual use during a surgical operation, and its mode of functioning was described in detail by close-ups and animated diagrams. Special attention was devoted to the method used for stopping and starting up the heart-beat, this being explained by one of the surgeons taking part in the filmed operation.

The amazing nature of the machine was apparent without any excess emphasis, and it was stressed that it had only emerged after an immense amount of experimentation on animals, surely a matter which must be seriously considered by the anti-vivisectionists.

The chairman co-ordinated with a brief discussion between his guests, ending with a striking quotation from Harvey, the father of it all.

From the points of view of science, of education, and of intrinsic interest, this programme of James McCloy's was undoubtedly a good deal better than the average in the same producer's "Questions of Science" series. There was a unifying thread throughout, due to the fact that all four participants were concerned with one, and only one subject: the bloodstream.

A real weakness in the "Questions of Science" was the multiplicity of quick-fire questions and answers, which must surely have dazed many untutored listeners. In the programme on Harvey the speakers had ample time. In a sense the talk of each one was "illustrated" by the talks of the others and so, with the leisure necessary to teach a difficult subject, the material was put across without the breathless clock-fighting haste often apparent in "Questions of Science" (which incidentally only had thirty minutes available for its broadcast).

Indeed if any criticism is to be offered it is that, despite taking up more than forty minutes, three rather than four participants would have sufficed. Surely if individual scholars and scientists are often given twenty minutes each on a pure sound broadcast like the Third Programme, they should be given at least fifteen minutes each on a visual broadcast, where time is taken up with visual illustrations. The educated public certainly can take it.

The BBC producers ought to set their sights high on these regrettably only too rare occasions when they get the chance to do so. Surely for forty-five minutes in a month the BBC can ignore those who are mainly interested in light entertainment and who no doubt find a continuous fifteen minutes of any one professor too much. Let these infidels turn elsewhere. The gain by the faithful will more than compensate.

S. TOLANSKY

The Scientific Film Association

The Fifth Annual General Meeting of the Scientific Film Association was held on June 27, 1957. The following films were shown: "Flagella and Motility of Spirilla", a research film produced by Prof. A. Pijper; "Animal, Vegetable, and Mineral", a Halas and Batchelor coloured sound cartoon on lubrication; "Four Back Rooms", a black-and-white film by British Transport Films (produced by Edgar Anstey) showing four research projects undertaken by British transport.

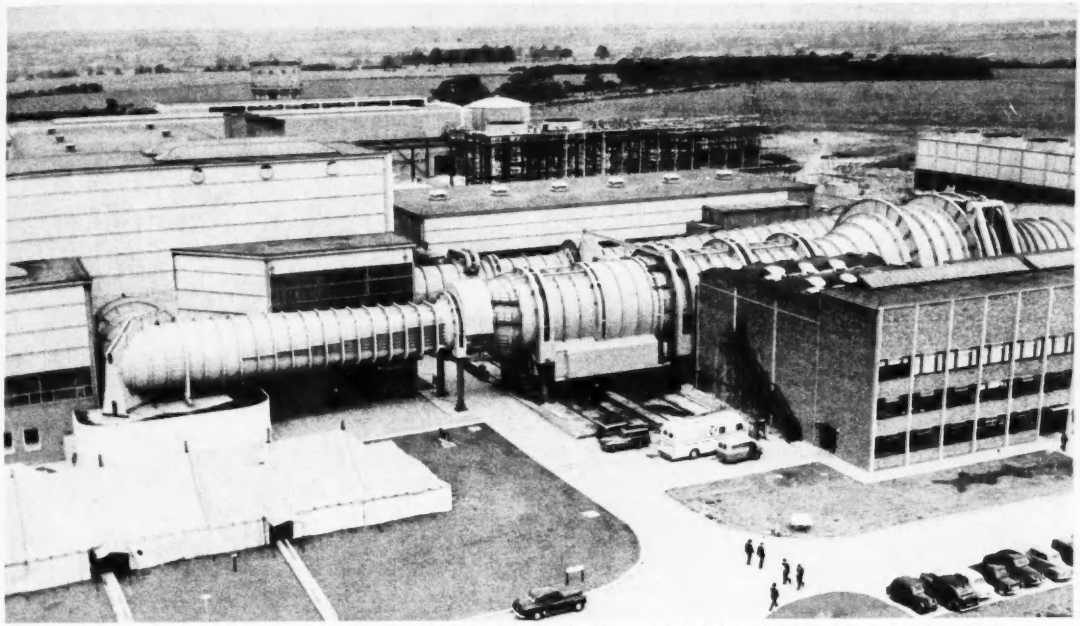
Lex Hornsby, Esq., C.B.E., the President, said that the immediate results of the development of a film information service had been encouraging. During the year under review the SFA had dealt with 700 film inquiries ranging from photo-elastic stress analysis to brake linings for racing-cars; from spermatogenesis in the grasshopper, to radar; from automation to the migration of eels; from leopard-hunting to psychiatry; from anthropology to atomic energy; from the movement of mitochondria in cells to servo-mechanisms. It had published in its journal, *Scientific Film Review*, reviews, appraisals, and detailed information on about 1000 films.

The Association presented a conference on "Film as an Aid to Management" at the residential conference centre of the British Iron and Steel Corporation. It had organised two residential courses on "First Steps in Industrial Film Making"; and had presented film shows at the Sheffield Meeting of the British Association for the Advancement of Science.

In the coming year the Association will organise public film performances for the Seventh World Congress for the International Society for the Welfare of Cripples; will select films and organise the British delegation for the Eleventh Congress of the International Scientific Film Association in Amsterdam in September 1957; will participate in the organisation of the Harrogate Festival of Films in the Service of Industry in October 1957; will organise a residential course on "The Use of Films in Supervisory Training"; and also evening meetings on subjects as diverse as French psychiatric films and research into animal locomotion through film. It will develop a circuit system of industrial film viewing for members of the Association; prepare special courses on the use of films in science teaching for the Oxford Institute of Education; foster the development of regional scientific and industrial film groups; conduct a pilot survey with the National Institute of Adult Education on the use of films in adult education; and prepare specialised (in some cases appraised) lists of films on Building, Education, Economics, Cerebral Palsy, Ophthalmology, Physics, Psychology, Recruitment and Vocational Guidance, Supervisory Training, Tuberculosis, and Work Study.

During 1956–7 membership had grown by nearly 20%.

ALEC HUGHES



The Royal Aircraft Establishment at Bedford. A general view showing the new 8 × 8 feet wind tunnel for subsonic and supersonic speed testing. This was opened by the Minister of Supply in June 1957.

FAR AND NEAR

First Gas Turbine Helicopter

A Westland Wessex helicopter powered by the "Gazelle" free-turbine engine has made its first flight. Its single "Gazelle" engine has been designed specifically for helicopters by Messrs D. Napier and Son Ltd. The flight was the first to be made in Britain by a helicopter driven by a gas turbine engine. The machine was piloted by Lt W. H. Sear, R.N. Retd., Westland's Chief Test Pilot, who was airborne for one hour five minutes. After initial hovering had shown that control and engine characteristics were satisfactory, the machine was flown through every type of manœuvre of which helicopters are capable and then at forward speeds up to 125 knots. Lt Sear said that the flight was entirely trouble-free and that the helicopter's performance exceeded expectations; he predicted an important future for it both for Naval and civil use.

The use of a gas turbine engine to replace piston engines marks a new epoch in helicopter development comparable to the change-over from piston engines to jet engines in fixed-wing aircraft. The absence of vibration and the reduction in noise effected by a gas turbine engine not only gives a smoother ride for passengers, but effects considerable reduction in the wear and tear of the helicopter's transmission system and main components such as the rotor head and gearbox.

Designed primarily for anti-submarine operations, the Naval version of the Wessex will also be suitable for search and rescue, communications and supply, casualty evacuation, and for training. Besides a crew of two, accommodation may be provided for twelve passengers and baggage, or for eight stretcher cases. For anti-submarine operations, it will be capable of carrying special equipment and strike weapons.

Westland hope that the first production types of Wessex will go into service in the latter part of 1958 or early 1959.

New Strain of Influenza Virus

A new strain of influenza virus "A" has been discovered in samples received from Singapore, according to a report received by the UN World Health Organisation in Geneva from its World Influenza Centre, in London. The same virus is believed responsible for widespread epidemics reported during May in Hong Kong, Taiwan, the Philippines, Cambodia, Malaya, Indonesia, Sarawak, and North Borneo. The London Centre describes the virus as a new variant of type "A" which differs in several respects from recently isolated strains, and has a number of "unusual properties" in its laboratory behaviour. For this reason it is thought possible that existing vaccines may not give satisfactory protection, and studies are in progress to determine the suitability of the new strains for vaccine production.

New Members of the Royal Society

At a meeting of the Royal Society held in May the following were elected Foreign Members of the Society: HANS ALBRECHT BETHE (Ithaca, N.Y., U.S.A.), for his contributions to many branches of theoretical physics. ALBERT FREY-WYSSLING (Zürich), for his studies on ultramicroscopic structure of protoplasm and of plant cell walls. OTTO HAHN (Göttingen), for his work on the chemistry of radioactive substances, for the discovery of several radio elements and especially for the discovery of the fission of uranium and thorium. ARNE WILHELM KAURIN TISELIUS (Uppsala), for his outstanding contributions in the field of physicochemical analytical procedures and their application to labile molecules of high molecular weight and biological importance.

In Britain, the Marquess of Salisbury, K.G., P.C., and Sir William Slater, K.B.E., have also been elected Fellows, for conspicuous service to the cause of science.

Sir Christopher Hinton Honoured

The gold Albert Medal of the Royal Society of Arts has been awarded for 1957 to Sir Christopher Hinton, K.B.E., F.R.S., "for outstanding leadership in nuclear power development". Sir Christopher has been Managing Director of the Industrial Group of the Atomic Energy Authority for Engineering and Production since 1954, and has

been closely connected with the Authority's programme since its inception in 1946. His name, of course, will always be associated with Calder Hall.

Theoretical Chemistry

Theoretical Chemistry will be the subject of a "Research" broadcast in the Third Programme on August 14. Participants include Profs. C. A. Coulson, David Craig, and H. C. Longuet-Higgins, and Dr S. L. Altmann.

Air-conditioned Telescope

Air-conditioning is a feature of a new British-built telescope on which a number of advanced types of electronic receivers will be tested for the first time at the Saint Michel Observatory in the Basses Alpes, France. The air-conditioning will ensure that air in the light path is at a uniform temperature, thus preventing distortions and consequent errors in photographic and spectrographic astronomy.

The main telescope tube has two skins, the inner one comprising fine woven nylon panels and the outer skin sheet Duralumin. When the telescope is in use, air is extracted from the space between the two skins by fifteen Woods of Colchester propeller fans. At the same time, atmospheric air is drawn down from outside the observatory dome into the interior of the tube and creates a continuous flow of air.

Eight 15-inch diameter and four 12-inch diameter fans, all diaphragm mounted, are fitted in the outer casing and three 9-inch ring guard units are fitted in the base. Together these fans are rated to move approximately 14,440 cubic feet of air per minute. Simultaneous control is provided by Woods regulators which have been supplied without cases for mounting in a central control panel.

The importance of distortion to light entering the telescope from a star may be gauged from the fact that star images upon the photographic plate will be as small as 1/1000th of an inch in diameter. To obtain sharp images of such tiny points of light the image must be stationary for long periods relative to the photographic plate itself. This means that not only must the air conditions be very good but also the whole telescope must be moved extremely smoothly to follow the course of the star.

The new telescope has been built at Newcastle upon Tyne by Sir Howard Grubb Parsons and Co. Ltd. It is a conventional parabolic reflector having a 75-inch aperture glass mirror. It is a universal instrument being arranged for use at the prime focus, Newtonian focus, Cassegrain focus, or Condé focus.

Problems of Ageing

The Trustees of the Ciba Foundation for the Promotion of International Co-operation in Medical and Chemical Research, 41 Portland Place, London, W.1, wishing to encourage research relevant to basic problems of ageing, invite candidates to submit papers of work in the field for awards for 1958. Copies of the regulations and form of application must be obtained from the Director and Secretary before an entry is submitted. Not less than five awards, of an average value of £300 each, are available for 1958. The announcement of awards will be made in July 1958. Entries must be received not later than January 1, 1958. They will be judged by an international panel of distinguished scientists. In making the awards, preference will be given to younger workers.

The papers may be in the candidate's own language. Papers should not be more than 7000 words in length and in all cases a summary in English not exceeding in words 3% of the length of the paper must be attached. If possible, ten copies of reprints in English should be provided. Where there is one or more co-author, the name of the leading author should be indicated; it is to him that the award will normally be made.

TV on Swiss Railways

Railway officials from all over Switzerland recently saw demonstrations of the first battery-operated industrial television system. The demonstrations, which were arranged by Pye Limited in conjunction with their agent in Switzerland, were carried out to allow the Swiss Railways to assess the possibilities of the use of television to increase efficiency and safety. The equipment, which is portable, is expected to find many new applications where it has so far been impossible to use television because no mains supply is available.

In Geneva the equipment, which operated off two 12-volt car batteries in series, was demonstrated viewing rail alignment from a moving train. Railway engineers were thus able to watch the track on a receiver inside the train. This equipment can also be used for examining springs and other inaccessible parts while the train is in motion.

The battery-operated equipment was also installed on a "tracteur", a small petrol-driven truck used as a service wagon. The Swiss railways are electrified, the overhead cables carrying 15,000 volts. This demonstration showed how, fitted with a telephoto lens, the camera could be used to examine the insulators on the overhead connectors. This equipment could also be used for examining, from the track, the inside of viaduct arches.

Standard Pye industrial television equipment was also demonstrated. A camera, set up in a railway goods yard, viewed train destination and classification marks on wagons, and relayed the information by both day and night, to television receivers in a viewing room. This showed how receivers could be installed in a signal box or office so that details of goods wagons in different parts of the yard could be noted at a central point.

Fast-Slow Reactor at Harwell

Harwell now has a fast-slow reactor, a simple modification having resulted in interesting changes to the characteristics of the fast reactor ZEPHYR. Graphite has been substituted for the uranium bars that originally formed the outer reflector. The thin inner reflector of uranium still surrounds the plutonium core.

In its new form the reactor diverged with a critical mass of plutonium very close to that in the uranium reflected system. Because the neutrons reflected back into the inner reflector have been slowed down, ZEPHYR now shows some of the characteristics of a thermal reactor. For instance experiments have shown that the chain reaction can now be controlled, as in a thermal reactor, by putting an absorber of slow neutrons such as cadmium into the graphite.

It is too early to predict the applicability of this "mixed" system to power-breeder reactors such as that at present under construction at Dounreay.

£A3 Gadget Boosts Balloons

A Melbourne physicist has sent a balloon filled with hydrogen twenty-one miles above the Earth by using a device which cost only £A3 to make. The device is expected to help research work on cosmic rays in the upper atmosphere, which Australian scientists are doing as part of the International Geophysical Year.

The inventor of the device is Dr Hopper, a Reader in Physics at the Melbourne University. It is a light metal tube, and has a ping-pong ball acting as a valve. As the balloon enters the rarefied atmosphere and the pressure inside becomes greater than outside, the valve allows some of the gas to escape and the balloon continues to rise.

Dr Hopper said the balloon climbs as high as balloons used by U.S. scientists which cost hundreds of pounds.

Olive-Growing Difficulties

The severe winter of 1956 caused serious damage to the olive trees of France, Spain, Portugal, and Italy. The situation was reviewed by the Working Party on olive growing and olive oil production, set up by FAO, which met recently in Rome.

In Italy the regions most affected were Umbria, Tuscany, the Marche, Abruzzi, Campania, and part of Apulia. Out of a national stock of about 160 million olive trees, 20% have been severely damaged. In Umbria alone, some 900,000 dead trees have to be replaced, and nearly 4½ million trees have to be stumped to strengthen the stem shoots. The olive trees regrown from two, three, or four stump shoots will take eight to ten years to bear fruit. The total loss in Italian production, calculating a minimum of 1 kilogram of oil per tree, and allowing for the 2 million dead trees, the 6 million topped, and the 12 million stumped, may be

estimated at 160,000 quintals per year for ten years.

In France also, the 1956 frosts may be considered a national catastrophe. The damage took the form of wholesale destruction in ten out of twelve olive-growing departments: 1 million absolutely dead trees, 3 million to be regenerated by cutting back, and 2 million to be pruned back to the main branches. Spain and Portugal also suffered severely, but there are no definite statistics for an exact appraisal of the damage.

Pergamon Institute

Pergamon Institute, a non-profit-making foundation, has recently been formed in New York, and is about to be formed in London to make available to English-speaking scientists, doctors, and engineers from all countries that are members of the United Nations, the results of scientific, technological, and medical research and development in the Soviet Union and other countries in the Soviet orbit. The President of the Institute is Sir Robert Robinson, F.R.S., and its offices are at 4–5 Fitzroy Square, London, W.1. Anyone wishing to know what is being published in the U.S.S.R. and other countries in the Soviet orbit may apply to the Institute to receive, free of charge, a monthly contents list in English of all the significant articles and books now being published in his field of interest in these countries.

Expanding Technical Education

"Technical education in this country is growing and expanding," said Lord Hailsham, the Minister of Education, in London recently. Opening the second National Conference between Industry and the Technical Colleges, organised by the Federation of British Industries, Lord Hailsham said: "The latest figures show that there were 4000 more full-time students, 32,000 more part-time day students, and over 100,000 more evening students than in the previous session which provided figures for the White Paper. The number of students attending part-time day courses in working hours had risen from 355,000 to 383,000."

"But," continued Lord Hailsham, "amongst our biggest successes is the way in which the public and the Press are beginning to take notice of what we are doing and, indeed, are even beginning to complain that we are not doing enough."

Jet Stream "War" Revealed

A team of meteorologists at the Air Ministry Meteorological Office climatological research centre at Harrow, Middlesex, have been working with slide-rules and graphs on a "synoptic study" of high-level observations made from Comet and Canberra aircraft and at scattered points in the Mediterranean and North African area. They have discovered that during the first ten days of 1954 high-altitude jet streams of over 200 m.p.h. were struggling for mastery, and wind systems were "squeezing together" over North Africa. The investigation followed reports from places in the region of the Mediterranean and Asia Minor during the previous six winters of winds approaching the same intensity, observed by radio-sonde balloons and the radar-wind network. These strong winds probably spread right across Asia in about the same latitude (30°–40° N.) each winter. Over the Mediterranean they were found to cover a very considerable breadth at times reaching over 800 miles. Phases of great intensity were separated by lulls lasting ten days or so. A full report of the investigations is published in the April issue of the *Meteorological Magazine* (*H.M.S.O.*, 2*s.* 3*d.* net).

Radioactive Teeth

Thomas Hedley Ltd opened during June their new research laboratories at Longbenton Newcastle upon Tyne. Of the many applications of science to household detergents, cake shorteners, and toilet articles, the following is perhaps the most outstanding. Human teeth received from dental hospitals were thoroughly cleaned in the laboratory and then sent to Harwell for insertion into a nuclear reactor. The resulting radioactive teeth were used for testing the abrasive properties of toothpastes. For this purpose standard toothbrushes were mechanically brushed over these teeth in small glass containers filled with a variety of dentifrices. Analysis of the radioactivity of the dentifrice solution after a standard time gave a direct quantitative measure of the abrasive activity of the product tested. The principle of this kind of abrasion test is nothing new, and four years ago was first brought to the notice of scientists when piston rings were made radioactive and the radioactivity of lubricating oil was then measured. It seems likely that after radioactive piston rings and radioactive teeth, many other unusual articles will yet find their way to the reactors at Harwell.

Nuclear Research Institute in Kazakhstan

A nuclear physics research institute has been set up under the Kazakh Academy of Sciences. The institute has about fifteen laboratories with the most up-to-date equipment. It will conduct research into the peaceful uses of nuclear energy.

"Frost Pockets" Take Toll of Red Pine

A little-known weather condition has been identified by the Canadian Federal Forestry Branch as the agent responsible for killing more than 200,000 red pine-trees at the branch's forest experiment station at Valcartier, Quebec. Investigations showed that the trees were planted in "frost pockets", areas where a layer of cold air accumulates near the ground on clear summer nights and brings killing frosts, in the growing season.

"Frost pockets" have been known to scientists for some time. However, when a large number of red pines were discovered dead or dying at Valcartier in 1946, the Forestry Branch decided to find the definite cause. Between 1946 and 1955, forest scientists tested many theories on the damage. Because only the lower branches of the trees were killed, it seemed unlikely that insects or a disease could have been responsible. The same evidence ruled out drought and deficiencies of minerals in the soil. The characteristic pattern in which branches were dead to a consistent height suggested killing by frost.

This theory was tested by experiments and a full study of the effects of summer frost made. One result of the study was the discovery that, although mortality may be heavy, surviving trees will eventually grow above the coldest levels and allow their new branches to grow in warmer air. It is recommended that studies of local climate be made in doubtful areas before planting.

Scientific Bibliography for Middle East

A series of abstracts of scientific and technical papers published in the Middle East is being issued by the National Research Council of Egypt, in Cairo. The bulletin is published monthly and is obtainable by subscription or in exchange for other scientific publications. Abstracts of papers published in Egypt and received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan, and Syria have already appeared. They are classified under pure and applied mathematics, astronomy and geophysics, physics, pure and applied chemistry, geological sciences, biological sciences, medical sciences, engineering, and agriculture and veterinary sciences. Applications for the bulletin should be made to the Director of the Scientific and Technical Documentation Centre, National Research Council of Egypt, Dokki, Cairo.

Museum of Primitive Art Opened in New York

A Museum of Primitive Art was opened recently in New York City, devoted to the artistic achievements of indigenous peoples of the Americas, Africa, Oceania and early Asia, and Europe. Founder and president of the museum is Nelson A. Rockefeller, who donated a collection of some 500 objects assembled over many years. It is planned eventually to include in the museum a library and photographic archives on primitive art.

Erratum

We regret that on pp. 284 and 285 the photographs of botanical research were attributed to the University of Cardiff instead of the University of Swansea, Singleton Park, Swansea.

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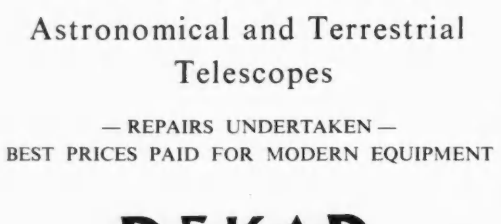

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Classified Advertisements

OFFICIAL APPOINTMENTS

COMMONWEALTH OF AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
WOOL TEXTILE RESEARCH LABORATORIES
APPOINTMENT NO. 462/99 OF
RESEARCH CHEMISTS

Applications are invited for appointment to two vacancies now existing in the CSIRO Wool Textile Research Laboratories at Geelong, Victoria.

These laboratories are involved in an extensive programme of research with the aim of improving the use of wool as a textile fibre. The Geelong Laboratory is primarily concerned with problems of wool processing, and the appointment of two Research Chemists with ideas and initiative is sought to carry out investigations on chemical problems associated with the wet-processing of wool. Excellent laboratory and pilot-plant research facilities are available. Opportunity exists for independent or joint research either in the development of new lines of research or in existing investigations.

Applicants should possess a University Honours degree in Science with Chemistry or Organic Chemistry as major subjects, together with some years of post-graduate research experience.

Dependent upon qualifications and experience commencing salary will be determined within the salary range of Research Officer, £A1313–£A1938 p.a. or Senior Research Officer, £A2048–£A2323 p.a.

The appointments will be conditional upon a satisfactory medical report and in the first instance, be for a fixed term of three years only, but opportunities may arise for appointment to a more permanent position at the end of the term, in which case the appointee would be eligible for Superannuation or Provident Fund benefits.

The Organisation will provide First Class Return sea fares for the appointee and his wife and family.

Applications quoting reference No. 462/99 and stating full name, place, date and year of birth, nationality, marital state, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials, and the names and addresses of at least two persons willing to act as referees, if required, should reach the undersigned from whom further particulars may be obtained not later than August 17, 1957.

(A. SHAVITSKY)
Chief Scientific Liaison Officer.
Australian Scientific Liaison Office,
Africa House, Kingsway,
London, W.C.2.

APPLICATIONS are invited for pensionable posts as

EXAMINERS
in the
PATENT OFFICE

to undertake the official scientific, technical, and legal work in connexion with Patent applications.

Age at least 21 and under 35 years on January 1, 1957, with extension for regular Forces' service.

Candidates must have (or obtain in 1957) 1st or 2nd Class Honours in Physics, Organic or Inorganic Chemistry, Mechanical or Electrical Engineering or in Mathematics, or an equivalent qualification, or have achieved a professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. For a limited number of vacancies candidates with 1st or 2nd Class Honours degrees in other subjects—scientific or otherwise—will be considered. Exceptionally, candidates otherwise qualified by high professional attainments will be considered.

Starting pay for five-day week of 42 hours in London between £605 and £1120 (men) according to post-graduate (or equivalent) experience and National Service. Maximum of scale £1345. Women's pay above £605 slightly lower but is being raised to reach equality with men's in 1961. Good prospects of promotion to Senior Examiner rising to £2000 (under review) and reasonable expectation of further promotion to Principal Examiner.

Application form and further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S128/57 and stating date of birth.

Interview Boards will sit at intervals, as required. Early application is advised.

JUNIOR WIRELESS TELEGRAPHY OPERATOR required by FALKLAND ISLANDS DEPENDENCIES ADMINISTRATION for service in SOUTH GEORGIA for one tour of three years in the first instance. Salary according to age and experience in scale £420 rising to £520 a year. Free board and lodging. Free passages. Liberal leave on full salary. Candidates must be SINGLE and able to transmit and receive morse at 25 w.p.m. They should be familiar with HF and MF transmitters. P.M.G.Cert. and ability to read reports in International Meteorological Code an advantage. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41977/DI.

DSIR requires Experimental Officers and Assistant Experimental Officers at the Hydraulics Research Station, Wallingford, Berks., for the following posts: (1) Civil Engineer or Geographer (ref. E.430/7A), for coast erosion studies at the Hydraulics Research Station or in the field; (2) Civil Engineer or Physicist (ref. E.431/7A), for Sedimentation Laboratory; (3) Engineer, Geographer, or Surveyor (ref. E.432/7A), for Survey Team; (4) Civil Engineer or Physicist (ref. E.433/7A), for hydraulic research on models. Qualifications: G.C.E. Advanced level in two scientific or maths. subjects or equivalent; over age 22, H.N.C. or pass degree generally expected. Salary at Wallingford for a 5-day 44-hour week: A.E.Os. (Men) £350 (at 18)–£615 (at 26) –£755. E.Os. (Men) £875–£1075. Women's scales being improved under Equal Pay Scheme. Favourable housing prospects for married staff. Forms from MLNS, Technical and Scientific Register (k), 26 King Street, London, S.W.1, quoting appropriate reference.

THE UNIVERSITY OF MANCHESTER

APPLICATIONS are invited from graduates for the post of ASSISTANT LECTURER IN PSYCHOLOGY. Candidates should have special interests or training in experimental and statistical psychology. Salary on a scale £700 to £850 per annum with membership of the FSSU and Children's Allowance Scheme. Applications should be sent not later than August 10, 1957, to the Registrar, The University, Manchester, 13, from whom forms of application and further particulars may be obtained.

APPOINTMENTS VACANT

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(*c*) ENGINEER with mechanical and electrical experience, and with a keen interest in precision welding of light engineering products, for development of equipment and techniques. Experience of engineering drawing, work handling methods, and some general experience of metal joining would be an advantage.

(*d*) PHYSICIST OR ELECTRICAL ENGINEER for research on the use of Ferrites and Ferroelectric Devices at microwave frequencies.

(e) PHYSICIST OR ELECTRICAL ENGINEER to work on new types of Telecommunications Line Systems. This could involve the application of transistors and the use of new techniques in the design of such systems.

Candidates for these posts, which offer considerable opportunities of advancement should be not older than 30 years of age and should preferably hold good honours degrees.

Apply in writing to the Staff Manager (Ref. RLO/132), giving full particulars of experience, qualifications and age.

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FAR AND NEAR—continued

Hard and Light

The Corning Glass Works of Corning, New York, whose Research Department has played a leading part for nearly a hundred years in finding new uses for, and developing new products from, glass, has just announced a whole family of new engineering materials with a wide variety of properties. Its scientists describe them as tough, heat-resistant, crystalline substances, harder than high carbon steel, lighter than aluminium, and fifteen times stronger than plate glass.

Pyroceram is the trade name that has been given to these materials. Over 400 compositions have been developed in Corning's research laboratories. The first use to which Pyroceram is being put is in the manufacture of radomes, nose cones for guided missiles.

From the tests that have already been made it is clear that there are many potentialities for the use of this new "synthetic metal" in a wide range of engineering, electrical, and optical products as well as in the home. Pyroceram can be tailor-made with thermal expansions ranging from slightly negative to high enough to match those of heavy metals. It can have electrical insulating properties superior to those of the best commercial dielectric ceramics. It can be made opaque or it can be transparent.

Experimental Pyroceram compositions have flexural strengths as high as 60,000 pounds per square inch. The strength-to-weight ratio of one Pyroceram is identical with that of annealed aluminium, greater than that of titanium and stainless steel.

Plastics for Farmers

At the opening of Australia's first Plastics Convention in Canberra, Mr McMahon said that already plastics were making three contributions to primary production. The first was the very practical one of providing light and flexible piping and hose for irrigation.

The second was in protecting the farmer's produce. Plastic bags were used to protect bananas and other fruit from insect pests and the weather and to assist even ripening. Milk powder packed in hessian bags was protected by a polythene lining. This enabled the powder to be kept satisfactorily for long periods.

Plastics were also being used more and more widely for packing food, notably cuts of meat prepared for export, which were sealed in polythene bags.

"Seeing-Eye Fountain Pen"

A device resembling a fountain pen, which enables blind people to distinguish between light and shade and even between colours, will shortly be produced by the Biophysical Research Foundation in the U.S.A., according to UNESCO. It consists of a wire and a small amplifier attached to a photo-electric cell which transforms light into sound. Brightness of the light determines the intensity of the sound signal. The "pen" costs about $21 and runs on a 12-cent battery which lasts one year.

Perpetual Light

A research laboratory in Schenectady, United States, has developed an electric light bulb which, it is claimed, will burn continuously for 100 years. The bulb, a replica of the first practical lamp invented by Thomas Edison in 1879, which burned for seventy-nine hours, owes its special quality partly to the discovery of ductile tungsten by Dr William D. Coolidge, director emeritus of the laboratory. The lamp is to burn in a lobby of the laboratory standing on a desk used for many years by Edison. Keys to the lamp have been presented to Dr Coolidge and to another American scientist, Dr Irving Langmuir, Nobel prizewinner, whose discovery of the gas-filled lamp also contributed to the development of low-cost, efficient electric light.

Mexico's Assault on Malaria

Malaria control has long been undertaken by Mexican health services, but now an all-out assault has begun with the assistance of the World Health Organisation and the United Nations Children's Fund (UNICEF) to suppress the disease completely. Four years and U.S. $20,000,000 will be needed to eradicate it, according to present calculations. Last year some twenty-two courses were held, under the supervision of six WHO experts, to train field teams and senior officials for the campaign. Maps have been prepared of each sector to be tackled, and itineraries worked out for each team. An army of 600 UNICEF vehicles, ranging from jeeps to heavy trucks, has been put at the disposal of more than 200 "brigades" of eight to ten men. Armed with sprayers containing DDT and dieldrin insecticides, also supplied by UNICEF, these teams will tour the countryside, disinfecting the houses, each of which is marked on the sector maps. According to present plans, a total of 3,350,000 houses will have been "DDT-cleaned" by 1960 and more than 13,000,000 people protected from malaria.

Brown Coal for Jet Engines

Australian experiments have produced promising results in the use of brown coal as a replacement fuel for oil in turbo-jets and other types of jet engines. Brown coal is available in large quantities in Victoria.

Safety in Atomic Energy

The Atomic Energy Authority Act 1954 places on the Atomic Energy Authority the duty of securing that no ionising radiation from any of their premises or from any waste discharged from their premises shall cause any hurt to any person or damage to any property.

The Authority have carried out their responsibilities under this Act through a number of committees dealing with the various aspects of safety policy. These bodies have now been organised in a new structure consisting of two main committees which will be served by a newly formed Safety Branch.

Factory on Skis

According to UNESCO, an unusual sort of factory may be built shortly in the French Cameroons to exploit deposits of natural gas. A number of small "gas pockets" have been found, especially in the Logaba region, but as they are not large enough to warrant the construction of separate factories, a mobile plant on skis is to be constructed which can be moved on from place to place as deposits become exhausted.

Second "Atoms for Peace" Conference

The second international "Atoms for Peace" Conference, organised by the United Nations, will be held in Geneva from September 1 to 13, 1958, just three years after the first meeting in the same city. A provisional agenda has been drawn up for the conference by the UN Advisory Committee on the Peaceful Uses of Atomic Energy. Procedure will be similar to that of the 1955 meeting, but exhibitions will this time be provided by participating governments only, and will be devoted to the scientific subjects dealt with at the conference.

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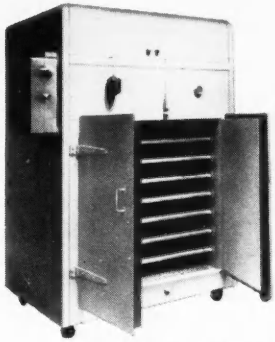

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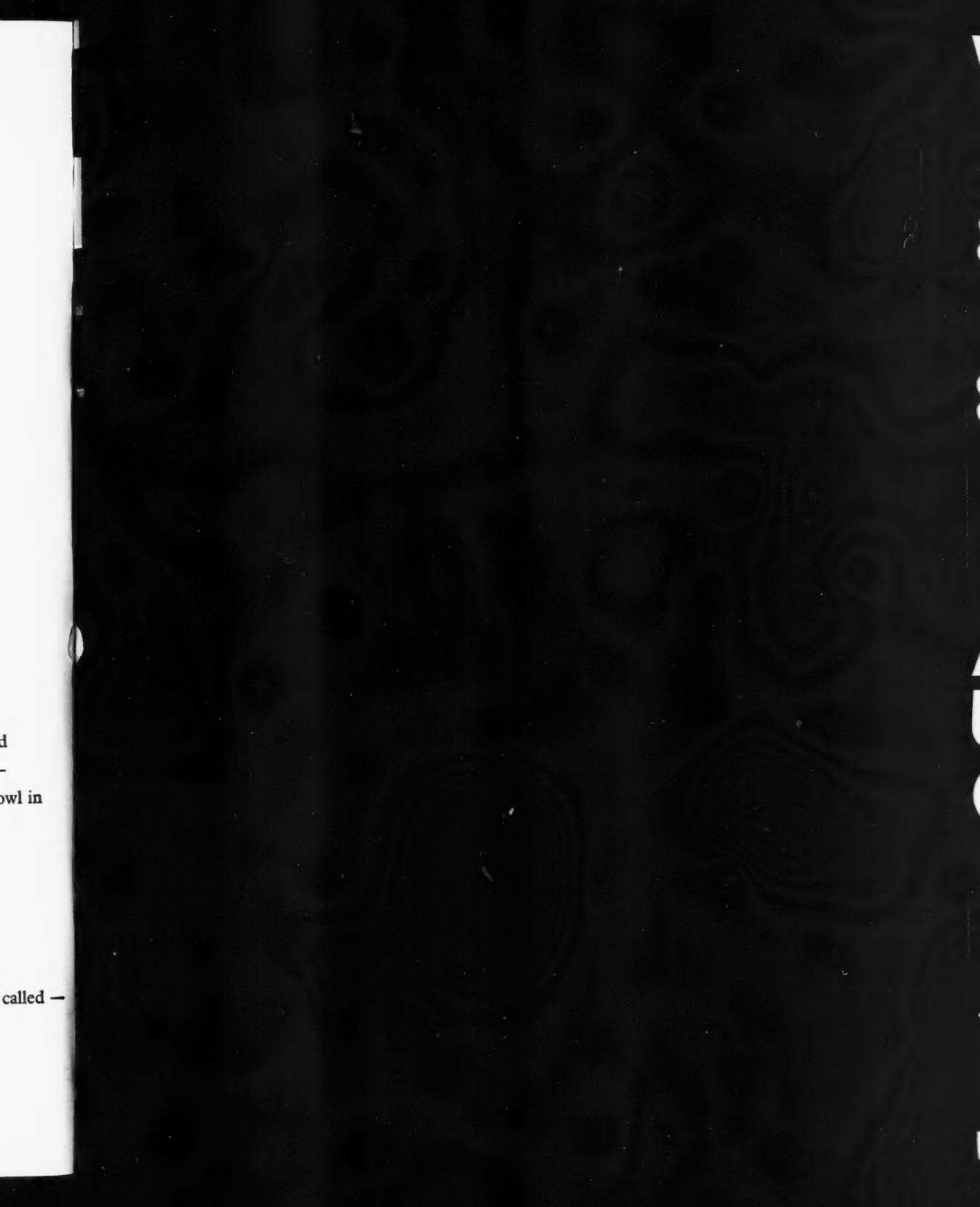
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